THE TELEGRAPHIC JOURNAL AND

Electrical Review.

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THE WEST INDIA AND PANAMA TELEGRAPH COMPANY.

Our readers will remember an article we published some little time since, as to the complaints, stated by certain West Indian journals as being very generally rife, with regard to the mismanagement, poor service, and overcharges existing in the West India and Panama Telegraph Company's system. We have to hand a copy of a Jamaica journal of the 20th October, in which appears an account of the proceedings at a recent meeting of the Legislative Council, when the question of the subsidy granted to the West India and Panama Telegraph Company came on for discussion.

It was pointed out, as one of the complaints against the company, that Jamaica paid a subsidy of £2,000 per annum to the company, and as a return for this generosity, the company actually charged a higher rate for messages to Europe from Jamaica than they did from Colon (Isthmus of Panama) viâ Jamaica, although no subsidy was received from the Columbian Government. The reason for this anomaly is that at Panama competition is met with from the Central and South American Telegraph Company, whose cables are in direct connection with the United States land lines.

Another complaint made against the company was that they had refused to deliver a telegram for Puerto Plata (St. Domingo) to the French cable company whose cables connect Cuba with Santo Domingo. The telegram was a reply from the owners of steamer (the *Tismone* of Belfast) wrecked near Puerto Plata, to a message from the captain of that vessel. It is stated that the reply was dropped into the Post Office to find its way by any chance occasion.

The Colonial Secretary read a letter from Mr. Earle, the chairman of the West India and Panama Telegraph Company, in which the charges previously brought against the company by certain journals were declared to be false and libellous. The general opinion of the Council, however, seemed to be that Mr. Earle's letter had made matters worse instead of better, so far as the conduct of the company was concerned.

Several propositions for ameliorating the present condition of affairs were made. It was suggested that the Government should lay a cable of its own between Colon and Jamaica, or Jamaica and Cuba; that the Central and South American Telegraph Company should be asked, under condition of a subsidy, to extend their system from Colon to Jamaica; that the home Government should be urged to lay a cable between Halifax, Bermuda, Nassau and Jamaica, a line which would be not only of public benefit but valuable to Government from a strategical point of view.

After the bestowal of a good deal of hard language upon the unfortunate directors, it was finally decided to grant a subsidy for six months only to the West India and Panama Telegraph Company, but at the same rate the previous yearly subsidy had been given.

Without expressing any opinion as to the merits of the case, we cannot help remembering that where there is smoke there is fire, and although the abuse of possibly an offended journalist may be regarded with indifference, the matter assumes a somewhat more serious complexion under the conditions we have just related.

BARNET ELECTRIC LIGHTING.

The discharged and revengeful workman is still a favourite excuse to urge in explanation of a breakdown; the legend of that much maligned individual is as old as the hills and is not always accepted with perfect faith, but it is ever fresh and comes readily to hand, so we are not surprised to find it cropping up again at Barnet to account for the collapse last Saturday night of the electric light. It may be, however, that the British workman was as little to blame in this case as in that of the cessation of the current from the Grosvenor Gallery station some months ago, when in explanation it was urged that the stokers had struck work because they were offered a cold dinner instead of a hot one. Our readers will perhaps remember that the stokers told a different tale through the medium of this journal and resented the allegation that they had left their posts without notice and for the slight reason stated. That contradiction, and the counter-accusation involved in it, has never yet been answered by the Grosvenor Gallery Company.

The Barnet undertaking has much to answer for; it has served, as few single installations have ever before served, to discredit electric lighting, and it has disgusted many people who were originally well affected towards the new form of street illumination. The numerous persons who are anxiously awaiting the advent of the electric light in their houses, according to a contemporary which swears by instead of at the Barnet installation, will, we expect, think twice before entrusting themselves to the tender mercies of the proprietors of this central station. Seeing the nature of the work, and the great risk of mishaps if anything but the best work and material is employed, we feel strongly that the contractor should have declined to undertake so serious a responsibility as the lighting of a town by means of hurriedly erected and admittedly defective plant and apparatus. It may have been that he would have lost the contract altogether had he not agreed to take over the lighting of the streets by a given time, a period too short to allow of proper and permanent arrangements being made; but better that than run the risk of incurring contumely, loss of reputation, and, possibly, after all, the forfeiture of the contract. Winter, with its frost and snow, has yet to be experienced, and it remains to be seen what its effect will be upon the overhead line, which, presumably, is not more free from defects than the rest of the plant. Why does not our contemporary, the champion of the Barnet installation, advise the contractor to have in readiness for the next breakdown a goodly number of 2 C.P. miners' safety lamps, with which to equip those inhabitants of Barnet who may be in the midst of their shopping when suddenly plunged into darkness. That may serve to conciliate them somewhat, and prevent them from saying some of the hard things now so freely uttered concerning him.

IT is not a little curious to watch the tactics of Colonel Gouraud and Mr. Henry Edmunds with the phonograph and graphophone respectively. The gallant Colonel reads a paper somewhere on his pet instrument, and Mr. Edmunds follows suit a week later, and so the ball rolls on. What is likely to be the upshot? One would think from casually following the papers and the discussions thereon, that a bitter rivalry existed between the phonograph representatives and the supporters of the graphophone; but who would like to say that they will not eventually come together and create another monopoly. Such a result, however, would not be likely to create an outcry, for nobody would be found with a desire to break down such a harmless combination.

THE new Pullman vestibule train, constructed for the London, Brighton and South Coast Railway, which made its first trip on Monday last, is lighted throughout by electricity, under the direction of Mr. Houghton. There is a dynamo worked by belting off the wheel axle of the guard's van, and the current thus generated goes to charge three batteries of accumulators. By an automatic arrangement, it is only when the train is running at a good speed that the brushes are put on to the dynamo. When the speed lowers or the train stops, the brushes are automatically disconnected, and the light supply is drawn from the accumulator. The number of lights is 80, and the total weight of the electrical apparatus is about three tons. This weight, contained in the guard's van, serves a useful purpose in the pulling up of the train. Train lighting by electricity goes on but slowly, yet surely the experience gained by Mr. Houghton and his collaborateur, Mr. Stroudley, on this line, and by Mr. Radcliffe on the Great Northern, should be sufficient to set all doubts at rest respecting the efficiency and economy of electric lighting. Its suitability and desirability are beyond question; cannot the gentlemen above mentioned demonstrate its advantages from the purely commercial point of view, which is all railway directors generally care to discuss?

WE are glad that the translation of M. Picou's article which we published last month, should have brought forth so much discussion. The subject is such an important one, that we trust others will follow Professor Jamieson and Mr. Russell. There are many electricians we could name who, if they would, could give much valuable information on the topic which M. Picou brought before the *Societé Internationale des Electriciens.*

WE believe that there are already in existence so many companies to which the name of Woodhouse and Rawson is prefixed, that a considerable amount of ingenuity is requisite to disentangle one from the other. This process of evolution is evidently going still further, for it is now announced that a proposition is on foot to transfer Woodhouse and Rawson, Limited, to "a large new company now in course of formation." The well-wishers of Messrs. Woodhouse and Rawson will probably wonder why this course is considered necessary.

WITH Sir William Thomson as the new President of the Society of Telegraph-Engineers and Electricians, it seems to us that a good opportunity offers for an endeavour to be made to secure uniformity of electrical engineering symbols. That this has not already been secured is thought, in some quarters, to be solely due to the negligence of Professor Fleming in not bringing forward a proof copy, similar to that contained in Professor Jamieson's letter of last week, and submitting it to the members of the committee for discussion, and getting the Society generally to sanction their conclusions.

AT the Council-meeting of the Society of Telegraph-Engineers and Electricians, on Thursday last, we believe the following motion was brought forward by the irrepressible London editor of *Industries*:—"That representatives of the Press be admitted to the meetings of the Society only on condition that they shall not aid in any unauthorised publication of the proceedings." What the result was we do not know, nor is it even easy to guess the motives which influenced Mr. Kapp in bringing forward such a motion; but this we do think, that such action on his part was utterly uncalled for. Some ill-natured persons might come to the conclusion that it was really an attempt to put obstacles in the way of the electrical Press publishing either papers or discussions at greater length than *Industries* can devote space to; this, however, is an idea with which we should never credit Mr. Kapp, notwithstanding his aversion from publishing anything which his contemporaries happen to get hold of first. To the best of our knowledge no complaints have ever emanated from the Society respecting the conduct of the technical press, and Mr. Kapp should be the last man in the world to attempt to limit the privileges so long accorded to the Electrical journals.

IT is rumoured, with what degree of truth we do not know, that a corner in transformers is about to come off between two well-known companies: one fond of litigation, and now extensively engaged therein, the other the holder of a patent which is claimed to cover all existing forms of transformers. We can scarcely think this rumour is correct, for it is not likely that the Grosvenor Gallery proprietors would pay a royalty on these apparatus after having defeated poor Gaulard and his partner. On the other hand, if our information *is* correct, the lawyers are likely to be in clover again.

THE meeting of the shareholders of the Maxim-Weston Company, the details of which we published very fully last week, is most interesting matter to read, learn, and inwardly digest. Extracts might be culled in profusion to illustrate the peculiarities of Mr. Watt, but they do not, generally speaking, implicate any other persons in business dealings, which may seem bordering upon the reckless, if nothing worse. That statement of Mr. Stent, however, which appears towards the end of p. 643, affords food for reflection, for it will at once occur to many that this is not the only instance which could be brought forward of an engineer receiving payment under like conditions. We have, however, too much faith in the honesty of purpose of the great majority of electricians to believe that such practices prevail to any great extent.

HEXHAM and Allendale, small towns away up in Northumberland, think they have got hold of a good thing in "Milburn's new patent electric light," which is, reduced to sensible language, a primary battery giving current to an Edison-Swan lamp. That any reasoning being should ever suggest the employment of primary batteries and incandescent lamps as a cheap and efficient means of lighting streets must fill more than ourselves with amazement. We can only surmise that Mr. Milburn finds in that out-of-the-way corner of the kingdom an unusual amount of simplicity and credulity, and is doing his best to turn his discovery to his own account. He has induced the Town Lighting and Improvement Committee at Allendale to adopt his system by the representation that a farthing per lamp per hour will be the total cost. We fear a day of rude awakening is in store for Allendale Town. A curious circumstance is that in the Hexham negotiations, so far as we can gather from the *Hexham Courant*, Mr. Milburn states that the illuminating power of the public lamps which he proposes to use will be 14 C.P. each, and the cost a fraction under a farthing per lamp per hour, whilst, almost in the same breath, he says that the cost of his 10 C.P. light is a halfpenny per lamp per hour. This looks like paying more and getting less. What is the meaning of it? A 14 C.P. lamp would represent an expenditure of approximately $\frac{1}{10}$th of a horse-power if run off a dynamo, and this power could not be obtained from any primary battery, either known or yet to be invented, in which zinc is used, for so small a sum as that mentioned. The scheme altogether is an absurd one, and will certainly not result satisfactorily to Allendale, if prosecuted. Mr. Milburn apparently perceives the hopelessness of following in the footsteps of previous so-called inventors of wonderful primary batteries by promoting a company to purchase his patents at a high price, and has struck out a new line for himself—a line, we may say, which is not much more creditable than the old.

A FORTNIGHT ago, it will be remembered, we expressed our surprise at the connection of the Earl of Crawford, the Hon. Reginald Brougham and others with the Mining and General Electric Lamp Company. We now learn that Lord Crawford, the Hon. Reginald Brougham and Mr. James G. Stephen resigned their seats at the board of the company prior to the allotment of shares. We are glad to hear this, and congratulate them upon their good sense. But are not those who applied for shares upon their faith in the names of these gentlemen entitled to ask why they resigned? why they joined the board in the first instance, and what were their reasons for retiring after the publication of their names had induced many people to become shareholders? We should advise shareholders, if they are dissatisfied with the position of affairs, to apply for the return of their money, for we feel sure that this is a kind of prospectus misrepresentation which would be construed by the Courts as entitling a shareholder to be relieved of his shares.

MR. OSWALD R. SWETE read a paper at the last monthly meeting of the Manchester Geological Society on the new miners' safety lamp, recently exploited by the company whose operations formed the basis for our leader of November 30th. We notice that he estimates the cost of maintenance of a two-cell battery and lamp, which gives a light of one standard candle, to be 2½d. per lamp per week, burning 12 hours per day for the six working days of the week. We do not hesitate to say that Mr. Swete's estimate is unreliable, for he only allows for 10 per cent. depreciation. This, we feel sure, is far too low, notwithstanding the use of lithanode plates, and although the lamp has been tested during a period of nine months, this is not sufficient to enable a trustworthy opinion to be given, nor have the experiments been on such a large scale as Mr. Swete estimates for. All things considered, therefore, we are convinced that the cost of maintenance of a plant of 1,000 lamps would, in practice, amount to a sum considerably in excess of that quoted. Still we fervently hope that the time is not far distant when mines throughout the country will be provided with electric lamps, and when this good time comes, Mr. Swete will be able to congratulate himself that his efforts have contributed in no small degree to that end.

WE have not yet had sufficient time at our command to analyse the figures given by Mr. Mackie in his report on the Paddington lighting. If they are correct then an investment in electric lighting stations is the right thing to go for, but they seem to be open to criticism in several places, so, perhaps, some of our readers with a taste for dissecting estimates may find the article on page 656 worthy of a little study. Has Mr. Mackie ever heard of any great difficulties in running arc lamps by alternating currents, say, on the Jablochkoff system?

THE Metropolitan Electric Supply Company, Limited, has cancelled the orders given to Messrs. Crompton & Co. for dynamos and batteries. We suppose our readers will soon learn whether any justification, legal or otherwise, for this apparently harsh course, can be advanced, for the London and Chelmsford firm is not likely to submit to anything which is incompatible with its ideas of fair play. It would be interesting to know who is responsible for such a grave breach of business relations between these companies. At all events, we are likely to hear more of this, so judgment must be suspended pending further information as to the rights and wrongs of the case.

PADDINGTON AND THE ELECTRIC LIGHT.

IN the ELECTRICAL REVIEW of November 16th, we stated that the Paddington Vestry had resolved to obtain plans and specifications to enable it to proceed with an application to Parliament for a licence to supply the electric light for public and private purposes throughout the parish. We are now in a position to furnish our readers with some further particulars. Mr. Mackie was called in for consultation, and he has just addressed an interesting report to Mr. Frank Dethridge, the Vestry Clerk of Paddington, on the subject. Mr. Mackie gives three estimates, A, B, and C. The first is for lighting by continuous current with underground copper leads for a unit installation of 2,000 16-candle-power incandescent lights. B is for the like unit of 2,000 incandescent lights, under the alternating system; while C, Mr. Mackie suggests, could be at once set up at the dustyard without interfering with any of the buildings and plant required for the dust work, and used in the first instance as a pioneer station. Station C has been designed to receive three continuous current dynamos for 1,000 incandescent lamps each, two continuous current dynamos for 50 arc lights each, and two alternating current dynamos for 500 incandescent lamps each. The total of incandescent lamps would be 4,000, and the number of arc lights 100 for streets and other purposes. The following are Mr. Mackie's reasons for advising this (C) station to be first adopted:—

1. That the site exists, and can be appropriated to the purpose.

2. That this (C) station can supply lights to any part of the borough, however distant, and to isolated customers or small groups of customers.

3. That the outlay will be the least upon which a central station can be based.

The respective costs of the A and B units are:—

A. Continuous current system with copper leads, as marked on map, the cost, including machinery and plant, would be £10,425 10s.

B. The alternating current system with light overhead wires, would be for machinery and plant £7,019 12s. 6d.

Showing a difference of £3,405 17s. 6d.

Judging of the comparative desirability of the continuous current system, Mr. Mackie thus sums up its features:—First, the current is never dangerous; second, the service is underground; third, storage batteries can be charged by it; and (fourth) consequently there is an additional very important safeguard against a breakdown, as (fifth) the accumulators can always supply current night and day for a limited time, and, therefore (sixth) the engines need only be run on the lighting after dusk or during fogs; or if (seventh) the engines are employed in the daytime in charging batteries of accumulators, an additional number of incandescent lights can be run at night.

As regards cost, Mr. Mackie is very explicit. He says that the cost of working and maintenance of the (A) continuous current unit would be £4,022 14s. 3d., of the (B) alternating unit £4,403 3s. Transforming the total current into cost of 16 candle-power lamps, the price per hour would be 0·2207 of a penny, and of the alternating current 0·2416 of a penny. Or in Board of Trade units (1,000 watts) continuous current 3·7519; alternating current 4·1072 pence. The price paid by consumers in both cases would be 7¼d. 2,000 lamps of 16 candle-power, running 2,186 hours, gives 263,320 Board of Trade units at 7¼d., yielding an income of, roughly, £7,924 per annum, less expenses of working £4,022, leaves a balance of £3,901, or a dividend of about 37 per cent. on the capital outlay.

The objections to the alternating system, according to Mr. Mackie, are: 1. That the current is of such high tension as to be unsafe for use in edifices or otherwise without the use of transformers to reduce its tension before entering the house to safe limits. 2. The engines must be run night and day, as (3) accumulators cannot be charged by alternating currents, and consequently there is (4) not that safeguard against breakdowns. 5. That arc lights cannot be so well run on alternating currents as on continuous currents, and each arc in street lighting, and each group in a building, would require a transformer. On the other hand, the advantages of the alternating current system are that the current can be carried for any distance by very small and comparatively inexpensive wires. Taking the income as before at £7,924 and the alternating current expenses at £4,403, the balance would be £3,521, or a dividend of 50 per cent. on the capital outlay.

The cost of the proposed C station would be £21,170; the income would be from the 4,000 lamps at 7¼d. per unit £15,583, and 100 arcs at £27 per year £2,700, or a total of £18,283. The expenses would be £10,027, giving a net profit of £8,255 on a capital of £21,170, or a dividend of nearly 39 per cent.

With his report Mr. Mackie encloses a map relative to the district to be lighted, and says:—"I would observe that the least costly but most effective route for the main electric current leads (continuous current laid underground) has been mapped out, and that this system taps the main thoroughfare of Edgware Road and the great mass of mansions lying between the central station at the dust yard and Hyde Park. This district is well calculated for securing a number of customers, and consequently of being a profitable district. I would, however, observe that the intervention of the Great Western Railway's extensive property between the dust yard, central station, and Westbourne Grove would cause an expenditure of some thousands of pounds for copper leads if served by continuous current of low tension. But this important district can be very cheaply reached by alternating current and overhead wires with high tension current reducible at customers' residences or shops by transformers. The suggested line of alternate current mains is shown on the map by a yellow line and dot. I may also remark that the Pioneer Central Station (C) system can be materially strengthened by three sets of storage batteries at, say, the spots marked blue on the map. It might be well to generally remark here that, as the (C) Pioneer Central Station is designed, a commencement of the permanent underground system is made; and that beyond this provision is otherwise made for supplying any person or any district that may desire it with electric light—the actual cost of length of light wire mains in each particular case being the only item which cannot be stated in advance, depending, as it does, on the particular circumstances of each ease. No mention has been made in this report of the use of electricity for motive power. The suggested (C) station, however, would be capable of supplying power in the daytime if required; and profit would accrue from this source. In regard to the powers to be taken by the vestry under the Act, those powers would extend to the whole borough, and all the inhabitants would be entitled to equitable treatment. It would not be needful for the vestry to incur the outlay and responsibility of extending the electric lighting over the whole area at once. They must, however, state in the Provisional Order the extent of area they will light in the first year; and how much extension of area they will light in the following three years. Beyond this the extension is purely optional, the vestry granting on applications from individuals or districts, or refusing if they chose to do so; the applicants having power of appealing against injustice to the Board of Trade. If the vestry wished to restrict their power to a minimum, the work to be done in the *first* year might be the erection of a *part* of the (C) station, say the erection of two boilers, two engines, and two alternating dynamos for 1,000 lamps. The work to be done in the following three years might be a portion of the continuous current system, and of the mains laid down on the map mentioned above, say the laying of the leads to the South Wharf Road. The remainder of the electric work would be done on application by individuals or districts, and the concurrence of the vestry therewith. The vestry having obtained powers for the whole borough, could at any time advance the general works beyond the legal liability incurred in the grant of the Provisional Order. Finally, I would say that the estimates given are, in my judgment, ample for covering any probable expenditure, and that if specifications shall be directed by the vestry at any time hereafter to be prepared the tenders sent in should be for less amounts. The estimates are all based on the supply of current only by the vestry; and it is distinctly advised that house and internal fittings be left entirely with the customers, except that in every case the vestry shall have the approval of the same as being proper and safe for the service."

In conclusion, we may state on authority that nothing definite has yet been done with regard to obtaining a Provisional Order, but that Prof. Forbes has been called in to advise the authorities upon the subject in addition to Mr. Mackie.

PECULIAR ROTARY MOTIONS FOUND IN LIGHTNING AND OTHER ELECTRICAL CURRENTS.*

By MOSES GREELY PARKER, M.D.

PHOTOGRAPHING lightning and making good pictures, representing the forked and irregular light as it shoots across the sky, or from cloud to earth, has become quite common, and is easily done in a dark night; having first focussed the lens for distant objects, one has only to point it in the direction he expects the flash to appear, expose the plate and wait for the lightning. If the night is dark, one can obtain several flashes of lightning on the same plate, as they often occur near together. The only difficulty is to have the flash come within the field of the lens.

Photographing the current itself so as to get detail in the track, showing how the electrical currents travel, is quite another thing; this we have been able to do and present some results.

From these we see that the electrical current may travel without dividing; or it may divide and subdivide, twist and meander in its passage from cloud to earth, its image on the negative presenting such a variety in form, that many names have been given descriptive of its general appearance, without any reference to the real motion of the current itself.

Three of these motions I have observed, viz: The twisted, the curled and the straight forward. Being unable to find anything descriptive of this in print, a short account may not be uninteresting.

The twisted motion resembles a loosely twisted rope; it twists both ways, usually from left to right, as the twining vine winds around its support. There are exceptions to this rule in the electrical, as well as the vegetable kingdom, for we find it twisting not only both ways (*i.e.* from left to right and right to left), but it reverses its motion in the same course.

The curled motion resembles a twisted ribbon or shaving as it curls from the carpenter's plane, and in some respects is most remarkable.

The straight presents straight lines in its track, and is evidently travelling with great force.

Before describing the figures, or saying more about these currents, it may be well to quote the report of the committee of the Royal Meteorological Society, London, England, on lightning. The report published this year is as follows:—

"1. Stream lightning, or a plain, broad, rather smooth streak of light. Only two or three specimens of this form have been received. The committee are disposed to consider this a distinct type of a single stream-like character without distinct irregularities or branches, and not merely the result of bad focussing, because other objects, such as trees, are extremely sharp.

"2. Sinuous lightning, when the flash keeps in some one general direction, but the line is sinuous, bending from side to side in a very irregular manner. This is by far the commonest type. It is very noticeable that the thickness of the line varies during the course of discharge. Sometimes the thinnest part of the white streak is the highest, and the flash appears to get thicker as it approaches the earth; at other times a flash in the air begins thin, broadens out in the middle, and fines away again at the farther extremity. The committee can offer no explanation of this at present, but they would call attention to the fact that in some photographs of electric sparks, taken from an induction coil, those of high tension are thinner than those of low tension.

"3. Ramified lightning, in which a part of the flash appears to branch off from the main streak, like the fibres from the root of a tree. Of course, there is no evidence as to whether these fibres branch off from, or run into, the main flash.

"4. Meandering lightning. Sometimes the flash appears to meander about in the air without any definite course, and forms small, irregular loops. The thickness of the same flash may vary considerably in different parts of the course, as mentioned above, and a flash may go pretty straight in one portion of its path, but meander considerably in another.

"5. Beaded or chapleted lightning. Sometimes a series of bright beads appear in the general white streaks of lightning on the photographic plate. Occasionally these brighter spots appear to coincide with beads in a meandering type, but often the beads appear without any evident looping of the flash. But as a flash is moving in space, while two directions only can be shown on the plane of the paper, there is every reason to believe that the brighter spots on the positive picture may be points where the flash was zigzagging, either directly toward or away from the observer, and thereby giving a somewhat longer exposure to those spots.

"6. Ribbon lightning. Nearly one-sixth of the photographs received by the society show flashes exhibiting more or less of a ribbon-like form. One edge of the ribbon is usually much whiter and firmer than the other. Occasionally in the same picture some flashes appear normal and others ribboned; but the flashes in a picture need not have occurred simultaneously. The committee have not yet in their possession any conclusive evidence as to whether the same flash may be normal in one portion and ribboned in another portion of its course. In one picture there is a bright streak on the top of the flash; then about an eighth of an inch of ribbon-like light, the folds following the sinuosities of the bright streak; then a dark band parallel to and following every irregularity of the bright streak, and then nearly another $\frac{1}{8}$th of an inch of ribbon-like light. In another picture a very thin beaded flash has a precisely similar beaded streak, rather fainter than itself, running parallel to it at a distance of about $\frac{1}{16}$th of an inch on the paper. It might be suggested that the second fainter image was formed by internal reflection from the back surface of the glass plate; but it should be noticed that sometimes very thin flashes, which are not particularly bright, are so duplicated. A far more probable cause is the double image formed by the internal reflections of doublet photographic lenses. All doublets are essentially two meniscus lenses, mounted with their concave surfaces facing one another. The greater portion of a strong point of light, passing through both lenses, forms the usual image on the plate, but a smaller portion is reflected from the concave surface of the front lens, and from thence back through the rear lens to the sensitive plate. The amount of displacement depends on the angle formed between the direction of the bright point and the optical axis of the lens.

"M. C. Moussette, of Paris, showed some photographs of the sun, in which this double reflection image was very conspicuous; and there is not the slightest doubt that some lightning flashes are bright enough to give this secondary image. M. Moussette also showed the photograph of a flash in which the centre of the flash was the whitest, with a darker edge on either side. This may have been produced either by a double reflection from the lens, or by internal reflection from the back of the glass plate. Two bands of light—the primary and secondary images—slightly overlapping would form an extra bright band where the overlap took place.

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* Read before the New York Electric Club, November 15th, 1888.

"In the majority of cases, the folds of the ribbon formation are most obvious when the course of the flash is square to the width of the folds, and they are but slightly pronounced when in a line with them. This would suggest the idea of a shaking of the camera in the direction of the folds of the ribbon; but, if this is so, the duration of a lightning flash must be much longer than is supposed. The committee hope to have the opportunity of making some experiments on the photography of sparks from a coil or electrical influence machine. In the meantime, they defer expressing an opinion as to whether lightning ever really takes a ribbon-like form till further evidence is available, but would point out that both sources of error—the duplication of the image either by reflection inside the lens or by reflection from the back of the plate—would be avoided by the use of single lenses, and of paper, instead of glass, supported films. The committee also forbear for the present from publishing a reproduction of a ribbon-like flash till they are satisfied that such a form of lightning really exists, and that the whole appearance is not due to photographic causes."

Some two years ago, while experimenting with electricity, I obtained a photograph, showing the dividing and twisting rotary motion of the electrical current. My plate was not quite in focus, but the image is sufficiently sharp to show that the current divides and rotates, not only on itself, but upon its fellow.

Knowing, as we do now, that the current has a rotary motion, we can see in the main track indications of this motion that would be impossible for any jarring of the camera to produce. Further investigation disclosed the three motions before mentioned, to illustrate which I have, by permission of A. H. Binden, taken his remarkable photographs of many flashes of lightning, about which it was truly said in the Boston *Herald* of July 29th, 1888:—"Mr. Binden has been singularly fortunate in securing, with his two plates, photographic reproductions of all the typical forms of lightning flashes mentioned in the committee's report."

The lightning flash examined as a whole, is seen to leave the cloud and reach the earth in an irregular, twisting, rotary manner, throwing off branches as it goes; these also twisting, rotating, and sub-dividing into the sinuous, ramified, meandering, beaded or chapleted, and ribbon lightning, mentioned in the Meterological Society's report, while the main current, rotating as it goes, finally enters the earth in a divided form, which plainly shows this twisting rotary motion in the main current as well as in its branches.

Stream lightning is well described by its name alone. In this form I find what I have called the straightforward motion. Its photographs show almost straight lines, without the curves indicating the rotary motion.

Sinuous, ramified, and meandering lightning are all very much alike, if we grant that which we can hardly doubt, viz., that they all may divide and sub-divide as they advance. In all of these we find a rotary motion, with a direction either from left to right, or right to left; in some branches both motions are found, and when well defined resemble the twist of a rope.

Beaded lightning has that about it that is much more interesting from a speculative point than either of the others. The explanation given in the Royal Meteorological Society's report of the beaded form hardly explains all that we find in and on both sides of this bead; for we see the rotary motion of this current before entering the bead to be in one direction, and immediately after leaving the bead to be in the opposite direction, plainly indicating that the motion sometimes changes in the bead.

Ribbon lightning has what I have designated the curled motion. In this one sees the resemblance to a curled ribbon. This current is evidently flat, with a motion that forms this ribbon into a curl. It somewhat resembles the beaded form, inasmuch as it is seen to change its direction, thus forming curls twisted in opposite directions and united, not by a bead, as in the beaded lightning, but by a white edge where the process of reversing its motion goes on, while at another point it presents the appearance of a curl pulled sidewise, being thin and narrow; afterward proceeding in a more regular manner than before. No possible shaking of the camera could produce this curled appearance.

That currents of electricity are influenced by the medium through or upon which they travel, is also seen, and to the well known theory that the resistance of the air changes its direction, may be added, that the current changes in size and contracts in volume as it enters the earth.

If we compare the size of these currents with the trees or other known objects, seen in the same photograph, taking into consideration the distance each one is from the lens, one must, by comparison, judge the size of large currents to be, while passing through the air, *several feet* in diameter; distance must always be considered in judging the size, for as the current goes from the lens its image on the negative gets smaller, and larger as it approaches it.

Sparks from an induction coil or Holtz and other machines give the same indications of the three motions found in the lightning; they are easily photographed; the variety is not so great as in lightning, but one has an opportunity here of varying the current in many ways.

The three motions, the reversing of the rotary motion in the continuous track of a spark, as well as the bead, are found in these currents as in lightning, and add proof that these currents and lightning are similar.

With one observation more, I close this paper. No doubt many have noticed what I am about to mention, but its frequency last summer attracted my attention. While travelling in Maine last August I noticed that many of the telegraph and telephone poles, which were of the native white cedar, twisted as this tree always grows, had been struck by lightning, and that the current, travelling from the top of the pole to the ground, always followed the twist in the wood, often taking a groove out of the wood from top to bottom, winding once or twice around the pole following the grain of the wood.

Whenever it struck a pine hole or tree, these being straight without twists, it ran down on one side, taking out the groove or tearing the bark down on one side only.

(A large number of interesting views of flashes of lightning and a few of artificial discharges of induced electricity were illustrated by means of the stereopticon and fully described by the lecturer.)

The Electric Light in New Zealand.—A Reefton telegram to the *Otago Times*, dated October 14th, states that Mr. Horton, electrician, formerly of Dunedin, and who latterly has been engaged in connection with the electric light installation at the Melbourne Exhibition, has been engaged by the Reefton Electric Company to complete the electric light system. The lighting was started about a month before, but owing to some defect in the insulation the required number of 500 incandescent lamps could not be kept at their normal degree of brillancy, the full capacity of plant [illegible] being about 120 lamps. These were perfectly satisfactory, but the number being quite inadequate to the demand it was necessary to appoint some qualified person, in the absence of Mr. Prince (who had left for Auckland) to find the defect and remedy it. Pending Mr. Horton's arrival the directors of the company decided not to keep the plant running, fearful that in the absence of competent supervision the dynamo might be overrun, and consequently injured.

ON THE DETERIORATION OF LEAD SHEATHING ON CABLES LAID IN CREOSOTED WOODEN CONDUITS.

ROBERT H. ENGLE writes to the *Electrical World*:—Among the many conduits devised none appear so antagonistic to lead-encased cables as those constructed of creosoted wood. Ordinarily they are constructed in sections of about 20 feet each and divided into numerous rectangular compartments, each of which is designed as a receptacle for a cable, which is pulled through by a rope from man-hole to man-hole, usually the distance of a square apart. Owing to the friction of the wood on the lead encasing in drawing it through, these compartments must of necessity be much larger than the diameter of the cable, and in consequence form a reservoir for the accumulation of vapours and gases. In a very short time a chemical action takes place between the wood, of which the conduits are made, and the crude creosote with which they are saturated or kyanised, and there are set free acetic acid and carbonic acid gas. The reaction of these two chemical agents upon the lead may be expressed by the following equation :

$$Pb + 2C_2H_4O_2 = C_4H_6PbO_4 + 2H.$$

$$C_4H_6PbO_4 + 2H + CO_2 = PbCO_3 + C_2H_4O_2 + C_2H_4 + O.$$

To express the reaction in words to those who may be uninitiated in chemical nomenclature : The first part of the first equation, lead (Pb) combines with the acetic acid ($C_2H_4O_2$) formed from the action of creosote on wood ; the second part to form acetate of lead ($C_4H_6PbO_4$) and hydrogen (H). In the second equation, lead acetate plus hydrogen plus carbonic acid gas (CO_2) set free in the conduit during the formation of acetic acid, unite to form carbonate of lead ($PbCO_3$), acetic acid, olefiant (C_2H_4) and oxygen (O) gas.

The acetic acid acts upon the lead, converting its surface into a film of acetate of lead, which, as soon as formed, is acted upon by the free carbonic acid gas, converting it into carbonate of lead, releasing free acetic acid, which attacks the next layer of lead below the one already acted upon, and so on, until the entire sheathing is converted into carbonate or white lead. These creosoted conduits are, therefore, practically underground white lead factories on an extended scale—"electrical conduits" seems to be a misnomer for them. Many have been the devices and suggestions to allay this chemical action, but no one seems to have arrived at anything that is at once economical, effective, and practical. Some suggest that a sheathing be made of an alloy of lead and tin that would effectually resist the chemical action going on. This would require an alloy holding a heavy percentage of tin, and while it might be effective it would neither be economical nor practical; not economical for the reason that the first cost would be too great, and not practical because a sheathing composed of an alloy requisite to resist the corrosive action would be so hard that the cable would be very rigid, especially cables of large diameters.

A great deal of my time has been taken up by laboratory experiments on the subject of finding a way to protect pure lead from these corrosive vapours and gases.

The fruit of these experiments is a compound that resists this chemical action. This compound by a very simple process is applied to the lead sheathing during the process of encasing the cable, adheres intimately to the lead when of the proper consistency, is perfectly pliable regardless of temperature, and will not crack or peel off. In addition to all of these sterling qualities it has also the advantage of being a perfect insulator. Messrs. Tatham and Brothers, cable manufacturers, of Philadelphia, will apply this compound to all of their cables that are to be laid in creosoted wood. Some no doubt will surmise that my compound is rubber or some of its compounds ; to those, suffice it to say, that rubber in no form enters into its composition. It is composed of mineral substances and hydrocarbons. This material is inexpensive, both in its first cost and in its application as a protective covering to lead, and seems to solve the problem of effectually protecting lead from corrosion in creosoted conduits.

STORAGE BATTERY LIGHTING IN AMERICA.

WRITING in the *Electrical World* of New York, Geo. B. Prescott, jun., says :—"In a paper entitled 'Electric Lighting in America,' by Prof. George Forbes, which was read before the British Association for the Advancement of Science at the Bath meeting this year, the following statement will attract the attention of the American reader :—'It is a curious thing, for example, that in America there is no work hardly being done with accumulators. There is an example where we have led the way as compared with the Americans. I was struck with the fact in 1884, and still more in the present year, that accumulators do not seem to work in the American atmosphere ; at any rate, people have been importing numbers of accumulators, and yet they are not recognised as the satisfactory apparatus we have come to regard them as ; they are looked upon there as being as uncertain now as they were with us four or five years ago.'

"For the sake of fairness, the writer, in the light of personally familiar facts, may be permitted to take exception to the foregoing statements. It is true that in England accumulators have been used quite extensively in connection with isolated plants, which have usually remained under the maintenance and personal supervision of the erecting engineers. But lighting from central stations by means of accumulators has hitherto been an unworked field in England, and the first practical schemes of that sort, seriously considered, are only just now being projected. In America, on the other hand, accumulators have been installed as auxiliaries to existing isolated plants as largely as in England—notably in New York and Philadelphia—and many such installations throughout the country depend partially, and some wholly, upon accumulators for their lighting current. These plants have, moreover, been sold outright to the users, who alone have been responsible for their proper maintenance ; and if it is true that accumulators have given better satisfaction in England than in America, this fact should not be overlooked.

"For the past two years central station accumulator installations have been operated in many of the smaller towns of the United States, where the cost of running a lighting plant during 24 hours of the day would have been prohibitory to any direct system. More than this, accumulators have been installed as auxiliaries in many of the central stations of the well-known direct lighting companies, and within the past six months even one of the most prominent of the Westinghouse local companies has equipped its central station with a battery of not less than 300 lights capacity, for the purpose of tiding it over a period of heavy load, during which the boilers and engines are taxed to their utmost capacity. In America the lighting of cars by stored electrical energy has proved a decided and permanent success, batteries being extensively employed for the purpose, while no less than three large concerns are actively exploiting accumulators for traction work.

"As it is a well-known fact that Prof. Forbes visited this country in the interest of the Westinghouse Company, it is neither surprising nor unreasonable that he should be more familiar with the accomplishments of that enterprising corporation than with the achievements of less prominent manufacturers in the newer field of storage battery lighting. But, while the results obtained may be less conspicuous than those which have been effected in the older and more extensively worked field of direct lighting, they are neither so few nor so difficult to discover but that any thorough investigator may easily discern them to be a permanent element in the art of electric lighting as it exists in America in the year 1888."

Electric Lighting in Ireland.—It is proposed to introduce the electric light to the town of Boyle, and the Town Commissioners are in communication with Messrs. Fahie and Son, of Dublin, regarding the projected scheme.

GANZ AND COMPANY'S CONTINUOUS CURRENT DYNAMOS—DELTA ("Δ") TYPE.

SINCE the beginning of the year 1887, Messrs. Ganz and Co., of Budapest and Leobersdorf, have manufactured a two-pole continuous current dynamo with drum armature, differing, however, from some other dynamos which resemble it in some important details.

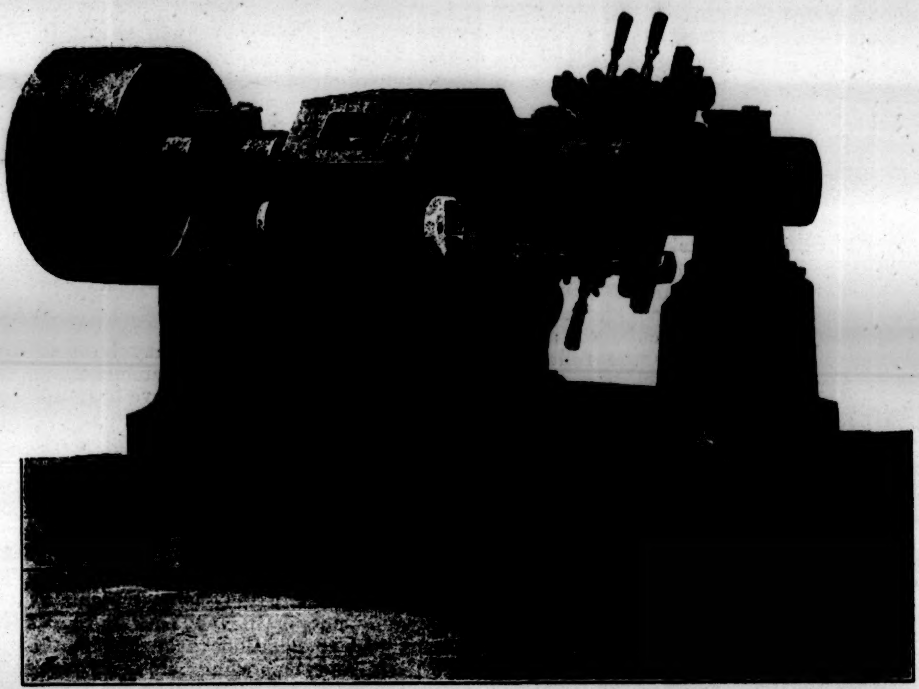


FIG. 1.

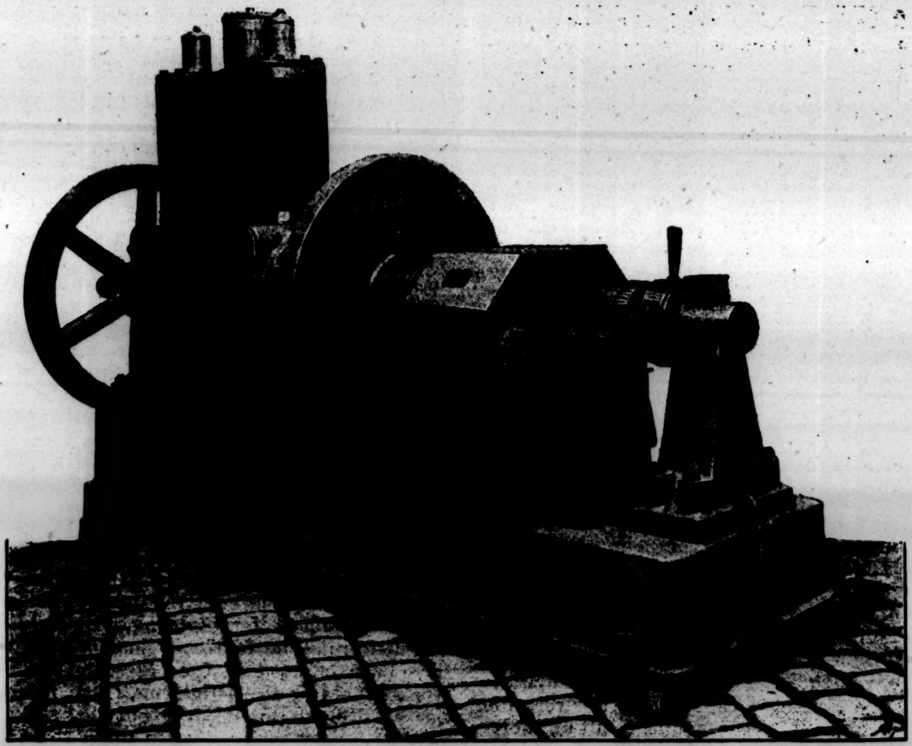


FIG. 2.

Fig. 1 shows such a dynamo for belt driving, having an output of 110 volts and 60 ampères, or 60 volts and 110 ampères. Fig. 2 represents a larger dynamo, coupled directly with a high-speed steam engine, and giving at 375 revolutions, 110 volts and 400 ampères.

The electro-magnets of the "Δ" dynamos consist of two separate wrought iron limbs, cast into the bedplate of the dynamo. A very low magnetic resistance results from this way of connecting the limbs, as well as from the circumstance that the grain of the wrought iron cores runs in the direction of the lines of force.

The drum armature, whose first construction dates as far back as the year 1885 (shown at the National Exhibition of Budapest), consists of iron discs 0·5 mm. thick, pressed together with thin paper between them. Round the edges of the discs grooves are made which are relatively much deeper than they are wide. The coils, which in the current types are of wire, are placed in these grooves.

The clearance between the armature and pole-pieces varies in the different sizes from 2 to 3·75 mm.; its magnetic resistance is consequently very small, but notwithstanding this there is exceedingly little heating of the pole-pieces, as the vibrations of the lines of force produced by the narrow teeth, and, therefore, the eddy currents in the pole-pieces, cause only a very small loss of energy.

Fig. 3 shows the iron core of the drum armature and the shaft, but without coils, and fig. 4 the drum and commutator, the former being already wound.

shaft. The bolts holding these bearings down to the sole plate are of brass.

The ends of the armature, after being wound, are stretched over with strong canvas, and the electro-magnet coils with glazed linen to keep out metal filings, &c.

The main terminals, which serve also for the purpose of holding the main fuses, are mounted on china, and fixed to the limbs of the magnets on a wooden base. The terminals for the magnetising current, likewise on china, are in the same manner fixed on the opposite sides of the magnets.

A strong perforated zinc plate, stretching from one magnet horn to the other, protects the armature from bodies falling from above.

With the exception of the commutator, all bright parts are nickel-plated.

The whole machine, when driven by belt, is placed on a belt-regulating gear, which again is bolted down to a wooden frame, on a suitable foundation.

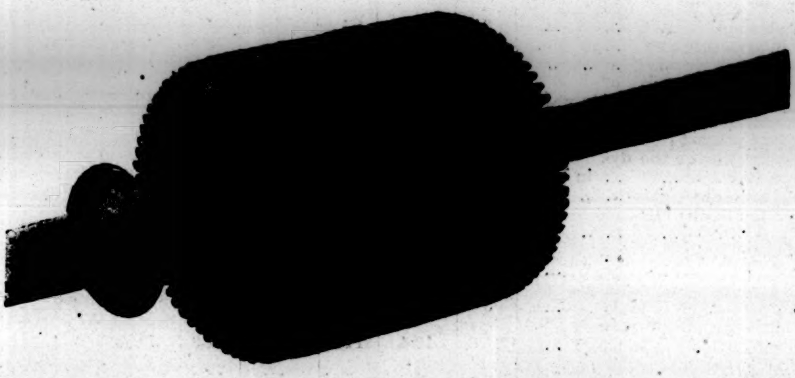


Fig. 3

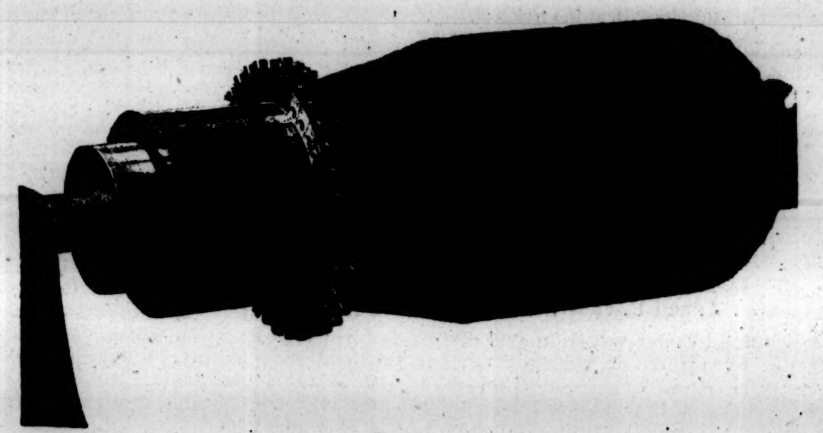


Fig. 4.

The unusually large copper commutator is also a characteristic of the "Δ" dynamo, affording a good and easily regulated contact and a long life.

The wire connections from the drum are by means of two set screws for each wire, clamped in the corresponding holes in the commutator sectors. The set screws are prevented from working loose by the very simple means of passing a short piece of wire through holes in the heads of the two screws which are in one sector, and then bending the ends of the wire backwards.

The number of brushes varies from 1 to 3. The pressure with which each of these bears on the commutator may be regulated at pleasure by a small hand lever, while, at the same time, the whole brush-holder may be shifted by the large hand lever, the inside end of which is a pinching screw.

The bearings in the smaller dynamos are altogether of bronze, while in the larger sizes they are of cast iron with bronze journals, but insulated from the bed-plate by a zinc frame, so as to avoid a detrimental leakage of the lines of force through the bed-plate, bearing and shaft.

When the "Δ" dynamos are made to be coupled directly with a steam engine, the magnet limbs are cast into a sole-plate common to both, the steam engine being insulated from the bed-plate by a zinc frame.

The "Δ" machines just described, either shunt or compound, serve at 110 or 60 volts for direct lighting, or for exciting alternate current dynamos (dynamo Δ *a*), with high tension for transmission of power and feeding arc lamps in series (dynamo Δ *b*), and with low tension for electro-plating and other electro-metallurgical purposes.

The regulation of the shunt dynamos is effected either by means of a resistance adjustable by hand, or by a resistance working automatically (automatic rheostat), but always by putting resistance into the shunt coils.

The following table contains the actual dimensions, weights and particulars, not as calculated, but as measured and weighed, of the usual six sizes of the shunt-wound dynamos.

C

TABLE.

No.	"Δ" Dynamo.	No. 0.		No. 1.		No. 2.		No. 3.		No. 4.	No. 5.
1	Maximum load ... ... in watts	1,800	1,650	3,600	3,300	7,200	6,600	10,800	11,000	22,000	44,000
2	„ current strength ... ... „ amps.	30	15	60	30	120	60	180	100	200	400
3	Potential difference across the terminals „ volts	56—60	100—110	56—60	100—110	56—60	100—110	56—60	100—110	100—110	100—110
4	Revolutions per minute	1,400		900		700		600		500	375
5	Length of bed plate ... ... in mm.	680		800		1,055		1,180		1,390	1,750
6	Breadth of „ ... ... „ „	350		435		520		570		720	1,000
7	Height of dynamo over all ... ... „ „	430		580		700		780		900	1,200
8	Diameter of pulley ... ... „ „	160		270		400		500		650	700
9	Breadth of face of pulley ... ... „ „	100		130		200		200		250	350
10	Diameter of commutator ... ... „ „	110		130		156		170		170	260
11	Length of „ ... ... „ „	80		90		130		126		134	178
12	Number of brushes lying next one another ...	1		1		2		2		2	3
13	Total weight of machine ... ... in kg.	240		490		840		1,150		2,100	4,400
14	Electrical efficiency ... ... per cent.	90·0	89·5	91·3	91·2	93·5	93·2	93·6	94·5	95·2	96·1
15	Commercial „ ... ... „ „	80·5	79·5	84·7	84·0	88·6	88·0	89·0	89·8	92·0	93·6
16	No. of 16 C.P. incandescent lamps of 64 watts, in round numbers	26	23	52	47	105	94	158	156	312	625
17	No. of 16 C.P. incandescent lamps of 53 watts, in round numbers	31	28	63	56	126	113	190	188	378	756
18	Width of grooves in armature core ... in mm.	4·2	3·4	5·0	4·2	6·3	5·0	7·0	6·0	6·3	6·3
19	Depth „ „ „ ... „ „	12·5	12·5	15·0	16·0	13·5	15·0	16·0	18·0	25·0	25·0
20	Loss of energy in the copper wires of armature ... ... in watts	47	45	122	108	230	216	390	360	640	1,120
21	Intensity of the magnetic field... ... in C.G.S.	13,200	13,900	12,800	13,400	14,400	13,700	14,700	14,000	13,900	15,100
22	Loss of energy in field magnet coils ... „ watts	154	150	225	210	280	270	360	300	520	670
23	Total weight of copper wire on the dynamo ... ... in kg.	10·8	11·3	23·6	20·2	39·1	33·4	59·7	58·8	113	258
24	Out-put per kg. of the total weight ... „ watts	7·5	6·9	7·4	6·8	8·6	7·9	9·4	9·6	10·5	10·0
25	Out-put per kg. of the total weight of copper ... ... „ „	167	146	153	163	184	197	181	187	195	171
26	Out-put per kg. of the armature ... „ „	790	920	600	580	710	720	570	670	600	650
27	„ in watts per H.P. at the pulley ...	600	590	620	610	650	650	650	660	680	690
28	No. of incandescent lamps of 64 watts per H.P. with 5 per cent. loss in leads ...	8·9	8·5	9·4	9·2	9·9	9·7	9·9	9·8	10·0	10·2
29	No. of incandescent lamps of 53 watts per H.P. with 5 per cent loss in leads ...	10·6	10·4	11·3	11·0	11·9	11·6	11·9	11·8	12·1	12·4
30	H.P. required with full number of lamps and 5 per cent. loss in leads	2·93	2·7	5·55	5·1	10·6	9·7	15·9	15·9	31·1	61·0

To No. 1, with either 60 or 110 volts P.D. at the terminals.
„ Nos. 16 and 17, calculated from the maximum ampères for lamps of 56 or 100 volts.
„ No. 20, under full load for several hours.
„ „ 21, with either 60 or 110 volts P.D. at the terminals.

To No. 22, under full load for several hours.
„ Nos. 24, 25, 26 and 27, with maximum ampères and either 60 or 110 volts P.D. at the terminal.
„ „ 28, 29, 30, lamps for either 56 or 100 volts.

REVIEWS.

Production and Distribution of Electricity from Central Stations. By Dr. MARTIN KRIEG. (Die Erzeugung und Vertheilung der Elektricität in Zentral Stationen.) Vol. II. Magdeburg: A. and R. Faber.

This volume is devoted to the production and distribution of electricity by means of constant current machines, whether with or without connection with secondary batteries. The author evidently forms a favourable opinion concerning the future of electromotors. They are already in Berlin proving widely useful in the smaller trades and in private houses. Sewing machines, medical appliances, coffee and rice mills, lathes, ventilators, printing presses, circular saws, cranes, hoists, &c., are set in action by their means.

The work commences with a general view of the best known continuous current machines which are most suitable for central stations. The question of accumulators is next taken up. A subsequent section is concerned with the various systems of distribution and their advantageous or disadvantageous features. Further chapters discuss the arrangements for regulation, the selection of the materials for conductors, their laying and testing. Full explanations follow on the erection, the management, and the remunerative character of central stations. Several of the more considerable establishments of this kind are next described, and in conclusion, we find methods for calculating the conductors for central stations.

The dynamos examined are divided into three groups, the drum ring machines, such as the Gramme continuous, those of Crompton, Alioth, Gisbert Kapp, Allen & Co., C. and E. Fein, Naglo, Mather and Platt, &c. Among the machines with flat or square rings, mention is made of the dynamos of Schuckert, Gülcher, Correns, Siemens and Halske, &c. Lastly machines with drum armatures and winding on the system of Von Hefner Alteneck are described. There is a special notice of the enormous dynamo, said to be the largest in the world, constructed by Brush for the Cowles Electric Smelting Company, of Ohio. Several of the machines receive favourable mention, but no one of them is pronounced distinctly more favourable than the others.

In the chapter on secondary batteries, the author insists, very justly, that no installation for electric lighting can be considered as perfect without a battery of accumulators to fall back upon in case of any irregularity in the supply of current from the central station. In the case of theatres, such a supplement becomes a positive necessity. A rather full account is given of an electric light installation established by the Frankfurt Gas Company, in which 260 accumulators of the De Khotinsky system are kept ready charged for the glow lights, and 156 for the arc lights. That a gas company should fit up such an installation is an edifying commentary on the contemptuous language in which certain organs of the gas interests have indulged towards electric lighting.

In speaking of distribution, always with a view to continuous current machines, the author distinguishes four direct systems, viz., the series, the parallel, the mixed arrangement, and the system of three or more conductors, and two indirect methods depending respectively on accumulators and transformers. The peculiarities of these systems are shown by diagrams. The author considers that the choice of a system must depend mainly on local conditions.

We find due notice of certain instruments which must certainly come into extensive use if currents of electricity from a central station are generally employed as sources of light and mechanical power. Meters for this purpose have been devised by Ferranti, Aron, and Siemens and Halske. Unless they can attain greater accuracy than the gas meters now in use, they will fail to give satisfaction.

Lack of space does not permit a more extended notice of this book, but we may safely pronounce it a useful work, carefully and conscientiously compiled, and free from the slightest suspicion of having been written in the interest of any manufacturer. The illustrations are numerous, and, for the most part, good, though a few of them, *e.g.*, fig. 23 might have advantageously been more distinct.

Materials for Estimating the Cost of Electric Light Installations. (Materialien für Kostenvoranschläge Elektrischer Lichtanlagen.) By ETIENNA DE FODER. Vienna, Pest and Leipzig: Hartleben.

We have here the sixty-ninth volume of that valuable series, "Hartleben's Electro-technical Library." The author's object is to supply the electrical engineer with such information, references, and fundamental matter, as may stand him in good stead in drawing up an estimate of the probable cost of any projected installation for electric lighting. He takes into consideration, firstly, the motive power, in which six cases are distinguished according as a sufficient motor already exists, or there is one present which requires improving though the source of power—steam, water, &c.—is adequate; or both motor and power have to be either enlarged, extended, or specially created.

He then defines the circumstances under which glow lamps or arc lamps are to be preferred, or both kinds are jointly required. Where only glow lamps are in use he pronounces continuous currents the more economical, but where transformers are employed he considers that the results with continuous currents are not as yet known. After discussing the arrangement of the dynamos whenever a single machine is insufficient he considers the cases in which accumulators are to be applied. Formulæ and tables are next given for calculating the conductors in accordance with the number and positions of the lights. The author shows that in installations which are to have a short daily service it is economical to reduce the section of the conductors to the utmost possible limit, whilst if the light is to be used for many hours daily no such proceeding is admissible.

In discussing the selection of dynamos he points out that machines with separate exciters are little affected by any accidental variation in the resistance of the conductive net. The series dynamo is not applicable for charging accumulators. The shunt dynamo performs better the more the resistance of the outer circuit increases, but it is more sensitive to irregular velocities of the motor than the foregoing. Compound dynamos require a constant speed of rotation and are to be used where a constant potential difference is required.

In the choice of accumulators the author advises that those with few and large plates should be preferred to such as have many small plates.

A special chapter treats of electric lighting with primary batteries. He shows that for this use only batteries can be used in which nitric acid serves as a depolariser.

As regards the duration of lamps, he thinks it unsafe to guarantee more than 800 hours of action per lamp, and that where a luminous power per candle of 3 to 3·5 watts is demanded the time guaranteed should not exceed 600 hours. It is also often required that within the guaranteed time the lamps should neither decrease in luminous effect nor require any increase of electric energy.

A general scheme is given of the estimated cost of a central station on the American system with a continuous current, a three-conductor system, and a capacity of 10,000 lamps in a densely peopled town.

There is also a scheme for a central station with Zipernowsky-Déri-Blathy transformers to supply 6,000 lamps. We find, also, schemes for a theatre, for a passenger steamer, for a light-house, for a man-of-war, for public gardens, for an exhibition, a technical school, and for various manufacturing establishments, in which, curiously enough, there is no mention of dye and tissue printing works.

As regards photometric appliances, the author approves of the German paraffine candle, "kerze," which he thinks varies less by 6—7 per cent. than the English candle and the French "bougie." The French carcel he thinks capable of great precision.

The book, on careful reading, will be found rich in useful little hints and cautions, which are sometimes overlooked, but which may make all the difference between success and failure.

Pumps: their History and Construction. By P. R. BJORLING. Manchester: Emmott & Co., New Bridge Street, Strangways. London: 6, York Street, Covent Garden.

This small book is a reprint of two lectures delivered by the author at the Gloucester School of Art. Although there are but 48 pages of letterpress, the matter is so concisely written, that an immense deal of most useful and interesting information is given. After a very entertaining history of pumps, the author proceeds to describe the different types of the same with numerous diagrams by way of illustration, his descriptions being remarkably clear though brief; details of the various parts are given. A summary, showing the advantages and disadvantages of the various types of pumps, adds to the value of the book considerably. The work, we may add, is thoroughly practical.

The Mechanical World Pocket Diary and Year Book for 1889.

This book, which is uniform in size with, and is published by the same publishers as the foregoing, consists of an ordinary diary with about 70 pages of engineering formula, after the type of Molesworth's pocket book. It is certainly a handy volume, and is deserving of commendation.

SPANISH SUBMARINE BOAT, THE "PERAL."

THE following information respecting the Spanish submarine electrical boat, the *Peral*, is extracted from the columns of the *Correo*, of Madrid, of December 7th.

Length over all, 88·5 feet; extreme beam, 9·98 feet; displacement afloat, 79 tons; displacement submerged, 87 tons; speed afloat, 11 N.M.; speed submerged, 10 N.M.; main machinery, two motors of 30 H.P. and twin screws; secondary machinery, two motors with small twin screws for steering when submerged; and a fifth motor to work a pump for the circulation of air.

The accumulators are of sufficient capacity to give the boat a run of 355 N.M. afloat, or 325 N.M. if submerged, without recharging, we presume. It is expected that the *Peral* will prove exceptionally handy and speedy in ascent and descent, in changing from moving ahead to astern and *vice versa*, and in steering.

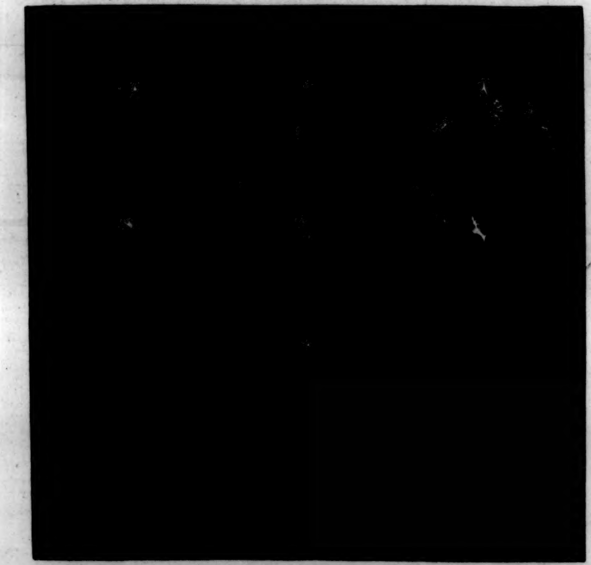
The designer, Senor Peral, claims that his scheme having been placed before the Government more than five years ago, has a priority of invention over the French submarine boat, the *Gymnote*. This latter, it is stated, has turned out in many respects a failure, the trials, conducted at Toulon, having developed so many defects that a very general reconstruction and modification of her design has become necessary.

It is suggested that the Government transport, the *Legazpi*, should accompany the *Peral* on her trial trip, carrying dynamos for recharging the accumulators of the submarine boat whenever required. The transport having plenty of accommodation could also take on board the members of the commission appointed for the official inspection of the new boat, with such members of the Press who desire to be present during the whole cruise.

The delays which have arisen with regard to the final and official trials of the *Peral*, and which ought to have been made two years ago, are due, it is hinted, to administrative changes, to official red tape not unmixed with personal jealousies, and to the slow progress inseparable from the conduct of Government affairs.

CURIOUS OPTICAL ILLUSION.

THE engraving, which we reproduce from the *Scientific American*, illustrates an interesting illusion observed by Mr. J. Rapieff, the electrician, who is doubtless as well remembered by many of our readers as by ourselves. The apparatus consists of semi-circular and circular wire loops, provided with axles, by which they may be twirled between the thumbs and fingers. The lower row of figures shows some of the loops used in the experiment, while the upper figures represent the effects produced. The wire has a polished surface. When the single semicircular loop is twirled, the only effect is to produce a gauzy glimmer of spherical form, as shown in the upper right hand figure. When three of the loops are joined together, each extending from the other at an angle of 120°, the figure produced is similar to that already described, but with two perfectly distinct curved black lines extending from one axle to the other, as shown in the upper central figure. When four loops are joined at right angles to each other, three jet black lines are shown, as indicated in the upper left hand figure. A circular loop shows a single black line.



This curious effect is produced by holding the apparatus so that the light is reflected as much as possible from the inner surface of the wire. The result is due to the eclipsing of the bright surface by the shaded portion of the upper loop as it passes between the eye and the lower loop. The whole of the loop is not eclipsed at the same instant, but persistence of vision causes the entire eclipse to be seen at once.

Success in this experiment depends upon holding the loops in the right position relative to the light, as well as the provision of the proper background. The loops should be held over a dark ground, with the axles parallel with the plane of vision.

Society of Arts.—On Wednesday, December 19th, at the fifth ordinary meeting of the society, a paper will be read on "Standards of Light," by W. J. Dibdin, F.I.C.. F.C.S.

THE TELEPHONE AND LIGHTNING.

WHILST research and statistics on one side, says the journal *Assecuranz*, have demonstrated that the number of thunderstorms, accompanied by severe strokes of lightning, have increased during the last 10 years, it has, on the other side, been proved that in larger towns both the number and effects of the same have considerably decreased. To the latter fact, no doubt, several of the inventions and discoveries of recent years contribute, among which the telephone nets now spread over the roofs of houses in towns are, we consider, one of the principal causes.

A large telephone installation, consisting of numerous wires of steel, suspended in the air over the houses like a huge steel net, each wire of which is connected either at the stations or in other places with the earth, where they again touch a network of gas and water pipes of iron, forms, with the latter, a kind of electrical safety wire fence above the city. For a city so enveloped is but a reality of Faraday's famous physical theory that a body completely encased in metal cannot become electrified through an electric current outside the metal case.

However, telephone installations do not act as lightning conductors alone by the wires at each end being connected with the earth, but also by most of the poles supporting the wires being of metal, and connected with the lightning conductors, if any, or by acting as such themselves.

The amount of protection which a telephone net affords to the buildings below it depends, in the first instance, on the local distribution of the wires, an area being the better protected by such a steel wire net the heavier and the more uniformly the metal is distributed over the same. Therefore that part of a city situated near a telephone station is the best protected, as the metal net is there thickest.

As regards the metal supporters on the roofs, those nearest stations afford the best protection, and next, those bearing the most wires. Those supporters, whence wires of any length emanate, should advantageously be connected with the lightning conductor, if any, or otherwise by points and earth conductors be converted into such, which will afford a still better protection for the buildings in question.

That a telephone net affords the protection here claimed for it, statistics from late years go to prove beyond a doubt, as, for instance, those relating to the town of Munich, where, in spite of numerous severe thunderstorms, no severe casualty through lightning has occurred since the city became enveloped in a telephone net. In suburbs and the country, however, were the factors described are absent, the cases have in no way diminished.

ELECTRIC LIGHTING IN THE ARGENTINE REPUBLIC.

WHILE we have constantly been able to give our readers news with regard to progress in electric lighting in the Colonies and in the Eastern hemisphere, and, while the gigantic strides that are made in the United States have been alluded to week by week, few particulars have been forthcoming in regard to South America, although it would have been surmised that the countries embraced by this Continent offered a fair field.

A few particulars that have come into our hands will probably be of interest to our readeas.

As early as 1882, the well-remembered "boom," which at that time was prevailing in England, with its attendant excitement and speculation in relation to "patents and concessions," seems also, to some extent, to have found an echo in South America, and the Cleveland Brush Company were on the ground endeavouring to avail themselves of the opportunity to secure a foot-hold. As far as Brazil, Chili, Peru, and some other countries were concerned, their perhaps somewhat premature efforts were not apparently productive of much result; at all events, there remains at present no indication of much success in the development of electric lighting in those countries, and we can reasonably presume that this has been due in a great measure to the same kind of initiatory mistakes and errors that were so frequently committed at that early period in the history of electric lighting. The usual method of temporary installations for purposes of exhibition in the public streets was followed, with the idea that the permanent adoption of the light would follow. This did not occur, however, in either of the countries above referred to, and we believe that at this date the small town of Campos, in the Province of Rio, is the only instance in the vast Empire of Brazil where the electric light has been taken up at all.

In the Argentine Republic, however, the Brush Electric Company appear to have fallen in with one of those enthusiasts for electric lighting, whose devotion and persistency, combined with means at command, have driven on to success. At that time, it will be remembered, it was the method of this company, and of others who laid claims to a "system," to dispose of territorial rights and concessions at high figures, and in the present case they did obtain a very respectable sum in cash from this enthusiastic and sanguine individual for their patents in the Argentine Republic.

We understand that in 1882 the concessionaire came over to London for the object of organising a company, but just at the moment when the tide had turned. Finding it impossible to induce any capitalists to embark in the business, the prospects for which then entered the most gloomy period, the alternative was presented to him either of losing his investment, or working the business entirely with his own means and upon his own responsibility. The latter course was adopted, and for two or three years an uphill fight, with very little results, ensued. When, however, the light in reality began to find favour, the fact of his having been the pioneer, and of having gained invaluable experience, gave him a most important advantage over all the competitors which in later times commenced to flock in, with the result that all the most important contracts seem to have fallen into his hands.

In regard to the work accomplished by this gentleman in the Argentine Republic, we have lately had the opportunity of learning some particulars, and of examining some photographs which relate to the same.

The most important installation is in the city of La Plata, the new capital of the province of Buenos Aires, which city although founded only some four years ago has already over 40,000 inhabitants, and photographs show it to be a city occupying a large area with wide and beautiful boulevards, and possessing numerous public and private edifices of sumptuous proportions and elegant architecture.

The electric light station, a photograph of which is before us, is a handsome and most spacious building standing in its own square of ground, 150 by 150 yards.

The interior views submitted to us show an arrangement of machinery on a scale and in an order that would excite the envy of many of our own electricians. Most of the engines and boilers have been supplied by Messrs. Davey, Paxman & Co., of Colchester. Four compound horizontal engines of 150 ind. H.P. each are shown in the photographs, side by side in a row, all work directly on to one long countershafting situated in a basement, and from it the driving belts come up to the dynamos arranged in rows along the same floor as the engines. This portion of the plant is employed almost exclusively for arc lighting. There are at the present moment nearly 400 arc lamps, for street lighting and for theatres, the railroad station, shops, and even for some private houses. Brush dynamos are mostly employed and have given every satisfaction. The original contract was for 200 arc lamps of 2,000 C.P., but this number has already been largely increased.

A most significant fact and one that emphatically indicates the success of the installation and its appreciation by the public and authorities is, that notwithstanding the efforts of a powerful gas company which secured a most valuable grant of land from the former Government, the contract has just been awarded to the electric light for the remaining portion of the city with 200 additional arc lamps, gas having failed to secure any foothold at all. We believe that this is one of the only examples in the world of a city of over 40,000 inhabitants which relies on electricity alone for public lighting. We have not space to speak of the incandescent lighting which is done and the further large installation for general domestic supply which is now in process of realisation in this remarkable city, nor would it offer any points of novelty or surprise to English minds.

There has been only one interruption in the light since it was fairly established and this was on the occasion of a severe thunderstorm, when no less than seven machines were injured, the lightning arresters being deficient. Since then, in spite of the frequent storms during which constant discharges of a remarkable and most unpleasant character are experienced, no interruption has occurred.

The lamp posts are placed at the intersections of the streets, in the middle of the road, and the city being laid out on a regular plan, each lamp illuminates in four different directions. This greatly facilitates arrangements and is perhaps the real reason why electric lighting in that place actually costs no more than would gas.

American practice has been followed generally, the wires being hung all overhead; but we are glad to know that some portion, at any rate, of the apparatus is of English make; indeed, we understand that nearly every principal type of incandescent and arc lamp has been tested, and as far as practical considerations will permit, it is not proposed to be confined to any one system.

The results in La Plata, which in all respects are said to be favourable, have naturally given the contractor there an enviable position for all work of this kind, and upon a future occasion we hope to refer to several installations made by him, or contracted for, in other cities, the most important contracts in the country having, as already stated, come into his hands.

Competition is now very keen in that market, the American companies, several prominent English firms, and numerous Continental makers are in the field, and the figures in tenders are now so low, that except to those who have acquired a strong foothold, there is little, if any, inducement.

NOTES FROM GERMANY AND DENMARK.

[A COMMUNICATION.]

THE first experiment in lighting the principal streets in Berlin by the electric light is now being made on the well-known "Unter den Linden," and, as it seems, with great success. The arc lamps used number 108, and they light the part of the avenue between the Pariser Platz and the Royal Palace. In the central avenue, lined with trees, 16 iron poles have been raised 25 feet in height, and covered with a guard above, from the tops of which chains descend into a semicircle, and being connected with the next pole carry the lamps in the middle. The poles are round, and at the base ornamented with lions' heads and the Imperial escutcheon, and crowned by an eagle. Along the pavements from the Brandenburger Thor to the Palace there are 46 arc lamps, about 30 yards distant from each other, but where the avenue crosses the Friedrich's Strasse the number is doubled. The electricity for feeding the lamps is supplied by four machines situated in the Mauer Strasse close by, each lamp having a luminosity of 2,000 candle-power.

The electric light is generally making great progress in Berlin, the number of lamps now in use being some 25,000, against 850 at the end of 1886. The National Library is now being illumined by this light, enabling the institute to remain open till 10 p.m., whilst nearly every *café* and larger shop nightly blazes with the light. There are four great block stations and two central stations in the middle of the town, besides minor private installations.

The light is also becoming extensively used in other German towns, there being now block stations in some 70 German towns, whilst the number of electric lamps in these towns has during the last two years risen from ½ to 2 per cent. of that of gas lamps. In the town of Elberfeld, one of the largest manufacturing centres in Germany, a municipal central station is in course of being established capable of feeding 10,000 glow lamps, the city having taken the precaution to secure 3,000 subscribers before the work was taken in hand. When finished the works will be driven by 7 steam engines of 100 to 170 horse-power, capable of working 14 dynamos; but at first only 3 engines and 6 dynamos will be taken in use. The price per lamp of 16 candle-power is for subscribers 23s. per annum for 570 hours' consumption; and otherwise, ½d. per hour. It is calculated that an argand gas lamp of equal strength costs only a fraction less per hour.

In Hamburg, too, a similar station is in course of construction by the municipality, being situated near the well-known thoroughfare the Jungfernstieg. It is intended for an equal number of lamps. The Royal Exchange in that city is now being lighted by electricity with 100 glow lamps within and 12 arc lamps without. In several other German towns central stations are also contemplated, as, for instance, in Lubeck, where one costing about £20,000 is to be established. In Temesvar the city is lighted by a private company through 730 glow lamps fed from a central station possessing 300 horse-power, the city paying 78s. per lamp a year.

The telephone is making immense progress in Germany, there being now hardly a town of a few thousand inhabitants which does not possess the necessary apparatus. At present, Berlin is in telephonic communication with Hamburg, Stettin, Hanover, Leipsic, Magdeburg, Dresden, Breslau, &c. Recently an experiment was made to communicate with Hamburg from the latter city *viâ* Berlin, a distance of 340 miles, which was a great success, and no doubt there will soon be communication right from the Russian to the French frontier.

Some successful experiments have also of late been carried out in the German Navy by using the telephone and microphone in diving operations, enabling the diver to communicate with those above, which were so successful, that in future these instruments are always to be used in such operations.

There are now exactly 10,000 telegraph stations in operation in Germany; the last one, making the round figure, having been opened on November 28th at the seat of the famous Count Moltke.

In Denmark the electric light is also making good progress, and shortly, no doubt, the City of Copenhagen will possess a central station, the agents of the Allgemeine Elektricitats Gesellschaft (Edison), of Berlin, having petitioned the Municipality for a concession, whilst the necessary capital has been provided. An offer has also been made to light the Opera House with the electric light.

Next year a new lighthouse will be ready at Haustholm, on the treacherous west coast of Jutland, which, it is said, will be fitted with the most powerful lights in Europe generated by electricity. H.M. the King of Denmark will turn the light on in state.

The Great Northern Telegraph Company, of Copenhagen, has obtained a concession from the Chinese Government for the laying of the first telephone line in the Celestial Empire, viz., from Tjentsin to Hong Kong, and several other concessions will shortly follow. *Apropos* of this company, the well-known journal, the *East Asiatic Lloyds*, published at Shanghai, in a recent number contains a very eulogistic article on the telegraph work effected by it in China and its excellent staff, this company having been the telegraphic pioneers in the exclusive Celestial Empire, and laid all its lines. On the other hand, Captain Suenson, director of the company, on a recent occasion stated, as an example of the development of the company, that in 1867, when the first cable was laid between England and Scandinavia, the messages forwarded to the former country numbered only 50,000 a year, against nearly 500,000 last year.

The receipts of the company for the half-year ending June last amounted to £132,000, against £127,000 during the corresponding period of 1887, and £125,000 in that of 1886.

CONTINENTAL ELECTRIC AND TELEPHONIC ITEMS.

TELEPHONY and telegraphy continue to make great progress in Belgium. A correspondent writing from Brussels says:—"Belgium is decidedly in the first rank as regards the applications of electricity. After the fine work of our regretted *savants*, Melsens, Gloesener and Plateau, after the striking discoveries of Van Rysselberghe, there is now to give the latter larger development another of our countrymen, M. Dejongh, who has invented a telephonic apparatus allowing speech to be transmitted to any distance and with perfect clearness. This apparatus, which shows such good results on the Paris-Brussels line, and which is already in use on a large number of lines, is about to be adopted by the most important telephonic company of Italy, La Societá Meridionale di Telefoni e di Ellettricita. This company, after having made trials with apparatus manufactured in the workshops of Mourlon, Brussels, is about to place at that establishment a large and important order for its Naples line."

At a recent meeting of the Communal Council of Brussels, M. Janssens, in charge of the public works department, read an interesting report summarising the studies on the subject of a communal organisation of a system of electric lighting. It was more especially an exposition of the difficulties of the problem. The intention was to make an appeal to the opposition, so that, from the early months of 1889, some propositions could be submitted to the council. After some remarks from MM. Martiny, Pilloy and Bède, and on the proposition of MM. Vauthier and Depaire, the report was sent for examination by a special committee of six members, to be chosen by the college and presided over by the public works official.

In a short time the Place Charles Rogier, Brussels, will be lighted by four new electric lamps. The installation works have just been begun.

On Sunday of last week the inauguration of public lighting by means of electricity took place at Dolham, in Belgium, and it may be said that the experiment was completely successful. The principal cafés of the town will in the future be lighted by electricity.

We hear from Calais that the submarine cable between Calais and Denmark has been broken and dispatches had to be sent *via* Berlin, but has now been repaired. This cable, which is 380 miles in length from Calais to the island of Farro, on the coast of Jutland, where it lands, was broken at mid-distance. It was laid down in 1873 by the Great Northern Telegraph Company. It communicates directly with Denmark, Sweden, Norway, Russia, Japan and China, and, in case of war with Germany, it would be called upon to play an important part.

SWINBURNE'S NEW FILAMENTS.

MR. VANDELEUR, of Moulsham, writes to the Ipswich *Daily Times*:—"I think your readers may possibly be interested to hear something about the new process for making incandescent or 'glow lamps' for electric lighting which has been worked out by Messrs. Swinburne, and which, if commercially successful, will be an entirely new industry for Chelmsford. Briefly the process is as follows, certain essential details, however, which the inventors prefer to keep secret for the present, being, of course, omitted. The essential novelty of the process consists in employing vegetable fibre for the 'filament' or thread, Almost any plant leaf will do, but after experiment it has been found that the leaf of the common cabbage answers the purpose best, as it is tough and fairly homogeneous in structure. Each leaf is first separately examined by polarised light to detect any flaws or holes, the smallest pin-hole rendering the leaf practically useless. It is then soaked in vinegar for 24 hours in order to neutralise the alkali in the fibre, and after thorough washing is ready for the next process. It is now laid out flat in a solution of mercury bromide; a rod of specially-prepared shellac is then taken, and after being raised to a high potential condition by treatment with a silk exciter, it is put into contact with the mercury solution. By this means the leaf is gradually electrolised, the potassium and sodium in the fibre combining with the mercury to form a coating of amalgam. In this state the leaf is a capital conductor, and the inventors have even succeeded in using it as a substitute for lead in secondary batteries. A heavy current is now passed through it so as to carbonise the vegetable fibre, the current being increased till every trace of amalgam is volatilised. It is then cut into filaments, and each is forced through a draw plate of polished chlorine. As it is not of sufficient 'resistance,' resort has to be had to a process called 'flashing.' This consists in passing a mixture of neumonia and hydrogen gases over it while it is heated by the electric current. The scaly brown incrustation of carbon monoxide is reduced by the pluronumonic acid formed (the exact reaction is not known, but is something of this kind—HN3 plus OC2 plus J=JO2 plus H5). The resistance rapidly rises, and at the proper point the current is automatically cut off by an ingenious switch arrangement. The filament is now bent into horse-shoe form and is ready to seal into the bulb.

Perhaps the most important discovery made by Messrs. Swinburne is the enormous increase in light that can be obtained for a given current by employing an atmosphere of slightly compressed oxygen in place of the complete vacuum hitherto customary; and though by this means the life of the lamp may be slightly shortened, it is not considered important in view of the great gain in light. If this process, beautifully simple as a laboratory experiment, should prove commercially successful, large quantities of picked and selected leaf will be required, and Messrs. Swinburne contemplate inviting tenders from some of the leading growers in the county. The bulk of the plant has been already erected, and Messrs. Crompton & Co., of Chelmsford, who are working overtime, have got the machinery well in hand, and hope to complete delivery by the 24th inst.

[We wonder how many "right bowers" Mr. Swinburne had up his sleeve when giving this information. —EDS. ELEC. REV.]

Ilfracombe and the Electric Light.—At the meeting last week of the Ilfracombe Local Board a long discussion took place with reference to the tenders received for lighting the town, several members contending that the tenders should not be opened in the face of the resolve of the Board to reconsider its requirements. Eventually it was resolved that they should be opened, but that the particulars should not be made public. There was one tender for lighting the town by electricity, one by oil, and one by gas, the latter being from the Ilfracombe Gas Company. The prices given by the electric light company, it was stated, when worked out showed that it would cost £1,500 a year to light the town in that way, whereas the gas company expressed its opinion that the town could be quite as well lighted as at present for £100 less than is now being paid. The total sum paid last year was £584 6s. 10d. It was finally resolved that the tenders lie on the table.

NOTES.

Church Lighting by Electricity.—The Rector of St. Martin's Church, Charing Cross, has accepted the liberal offer of a firm of electricians to instal the electric light—free of charge to the parish—in his place of worship.

The Electric Light at Cannock Chase.—At the bi-monthly meeting of the South Staffordshire and East Worcestershire Institute of Mining Engineers, at the Mason College, Birmingham, Mr. Arthur Sopwith, M.I.C.E., read a paper on "Electric Lighting at Cannock Chase Collieries." He described the system most fully, exhibiting lamps and copper cables used in lighting the collieries, and compared the cost of electric lighting with gas in favour of the former. He then described an effective method by which the cables were protected by being enclosed in rough boxes and protected inside the boxes by coal dust and tar. The shops, village church, schools and houses were lit up by the light, and there were 80 lights in No. 3 pit. A long and interesting discussion followed, and the President spoke of the paper as a most excellent one, free from too much science, and laying before the meeting a positive and valuable accomplished fact.

Cowpen and the Electric Light.—On Wednesday night last week an informal meeting of a committee composed of all the members of the Cowpen Local Board was held to consider the advisability of lighting the township with electricity. The chairman had called the meeting hurriedly for the purpose of hearing an explanation from Mr. Nicholson (Messrs. Jennings and Nicholson, electrical engineers, London). After the explanation and conference, a memorandum of agreement was drawn up and initialed by the chairman on behalf of the Board, and Mr. Nicholson on behalf of his firm, for lighting the township with the electric light.

The Electric Light at Leeds.—Boar Lane, Leeds, has not been left long without the electric light to which it had of late become partially accustomed, and, thanks to the enterprise of Mr. Monteith the proprietor of the Pygmalion, the approach of night sees the darkness and gloom once more dispelled by a bright flood of light. Hung in various parts outside the building in Bank Street and Trinity Street, as well as in Boar-lane, are 16 arc lamps, while the interior is illuminated by means of the incandescent or glow lamps. Rows of pendants run the entire length of the shop, supporting clusters of lamps fitted with opal shades that direct the cool light downwards. There are nearly 200 of these cluster lights, provided with between 500 and 600 lamps of 16 and 32 candle-power. The machinery which supplies the electricity consists of a Robey locomotive boiler of 200 H.P., and a pair of Robey's high speed 25 H.P. nominal compound engines for driving the dynamo. The dynamo is one of Schuckert's self-regulating machines, capable of supplying about 800 lights. On the wall near the dynamo is a fine mahogany switchboard containing 14 switches, each one on a slate bed, and all the circuits are governed by the patent switch of the electricians who have supplied the apparatus, the Schmidt-Douglas Company. Every precaution has been taken against danger to the employés.

Greenwich and the Electric Light.—At last week's meeting of the Greenwich District Board of Works, the District Committee reported that it had considered the application by the London Electric Supply Corporation, Limited, for the consent of this board to the application by the Corporation to the Board of Trade, for a licence to supply electricity within the district of the board, and also the form of licence for which the Corporation propose to apply. The committee considered it would be for the public advantage that electricity should be supplied within this district, and recommended that the board give consent to the application for the licence. This report was agreed to.

Electric Lighting in the Strand.—The House-to-House Electric Light Supply Company intends to apply to the Board of Trade for a Provisional Order authorising them to supply the electric light for the Strand district. The proposed order will empower them to purchase such lands as may be required, to construct such central and other stations, works, &c., as may be necessary for the generation and distribution of the light, to lay their wires over, along, or under the ground, and to break up the streets as needed; also to cross the Thames and to break up and cross with their lines the Metropolitan District and the South-Eastern Railways, to enter houses and other premises for any purpose relating to the supply, to make agreements with the Vestries or Local Boards as to carrying out the work, and so on, in the usual form under Provisional Order.

Paris Exhibition Lighting.—The payment for the electric lighting at the next year's Paris Exhibition is calculated on a service of 900 hours, and will be made at the following rates for the whole time the exhibition is open:—

Each glow lamp of	16 candles	... ...	60 francs.
„ „	10 „	... ...	45 „
Each arc light of	500 „	... ...	500 „
„ „	1,000 „	... ...	750 „

Should the lighting be required beyond the 900 hours, additional payments will be made as follows:—

			fr. c.
Each glow lamp of	16 candles	... ...	0.04 per hour.
„ „	10 „	... ...	0.03 „
Each arc light of	500 „	... ...	0.75 „
„ „	1,000 „	... ...	1.00 „

The motive power will be supplied at the following rates:—

		fr. c.
Up to 500 H.P. hours	... ...	0.50 per H.P. hour.
Beyond 500 H.P. hours	... ...	0.40 „

The illumination will consist of—

Jablochkoff candles	124
Arc lamps	1,017
Glow lamps	9,080
Sun lamps	16

having a total illuminating power of about 1,600,000 candles.

The Electric Light in the Royal Navy.—The Admiralty have decided to provide complete electric lighting installations on board the *Nile*, *Hero*, *Agamemnon*, *Colossus*, *Conqueror*, *Shannon*, *Forth*, *Champion*, *Basilisk*, *Beagle*, *Redbreast*, *Redpole*, *Magpie*, *Goldfinch*, *Lapwing*, *Ringdove*, *Widgeon*, *Thrush*, *Kingfisher*, *and Sparrow*, and a contract for the supply of the plant, which is to be delivered at Portsmouth, has been entered into with Messrs. Willans & Robinson of Thames Ditton, at a total cost of £11,095 6s. Three sets are to be supplied to the *Nile*, two each to the *Agamemnon* and *Forth*, and a single set to each of the other vessels. The combinations to be used are six Willans-Siemens, twelve Willans-Mather and Platt, and one each of Willans, Elwell-Parker and Latimer Clark, Muirhead & Co.

Rotherhithe and the Electric Light.—At the last meeting of the Rotherhithe Vestry the clerk read a letter from Messrs. Deacon, Gibson, and Medcalf, on behalf of the Electric Supply Corporation, Limited, stating their intention to apply for a Provisional Order for the supply of electricity in the parish, and asking for the Vestry's support. It was ultimately resolved to refer the matter to committee.

Electric Light for Windsor.—The Windsor and Eton Electric Light Company has just been formed, with a capital of £30,000 in £5 shares, and founders' shares of £1 each. The shares are being rapidly taken up. Lord Churchill is chairman of the company, whose object is to instal electric light apparatus in Windsor and Eton. Many parts of Windsor Castle are already thus lighted, but the apartments occupied by the Queen are illuminated by other means.

Barnet in Darkness.—Saturday night was the third occasion, since the adoption of the electric light, on which the town of Barnet has been plunged into darkness. On this occasion the electric light was brilliant from dusk to about 7.30, when it suddenly went out. A thick fog prevailed, and for some time pedestrians were literally groping their way. Even in the most favoured parts of the town the inconvenience was considerable, and trade was practically at a standstill for a short time. The police were on the alert, but some few tradesmen complain of the loss of certain of the wares which were exposed for sale outside their shops. It was alleged that a wire had been maliciously cut and the circuit so broken, and further, that a workman recently discharged by the contractor, was suspected of the outrage. A more probable explanation, however, is to be found in a letter which the contractor recently addressed to the Local Board, informing them that he was about to make a change from temporary to permanent engines and plant, and asking to be excused if, in the transition state, any hitch should occur; he added that no difficulty was anticipated. Whatever the cause may have been, the light was not again available for nearly two hours, and the public, particularly the tradesmen, gave free expression to their annoyance at the failure of the light. Later information from a friend resident in the neighbourhood is to the effect that the extinction of the light was caused by the breaking of the conductor, caused by wet weather.

The Electric Light at Leamington.—At the monthly meeting of the Leamington Corporation on Monday, Alderman Flavel (Mayor) in the chair, a discussion took place respecting the lighting of the Parade with electricity by Messrs. Chamberlain and Hookham, as representing the Midland Electric Light and Power Company. The question arose on a report by the Watch Committee, who recommended that a decision should be at once arrived at respecting the three alternative systems with which the company are now experimenting in the town, and calling upon the company to state forthwith the cost of supplying each system, as well as all charges for maintenance. Mr. Davies repudiated the notion that the council had unfairly criticised Messrs. Chamberlain and Hookham, or had in any way cast reflections on their ability as electrical engineers. Those gentlemen had promised to give the best possible exhibition of the arc system, but the result had been invariably unsatisfactory, one arc light being always bad, frequently two were defective, sometimes three, and occasionally the fourth. The "Sunbeam" system furnished a beautiful light, but as it involved an outlay of £600 a year, its adoption was practically out of the question. The 50 candle-power lamps in Bath Street would entail a still greater permanent charge. On Sunday night, anyone who saw in the soiled glass globes on the Parade the red firefly which they contained, would be out of his senses to imagine that such a light would attract people to Leamington. The light would not attract a moth. In his opinion the cost of lighting the Parade efficiently by electricity would be so great, that the game would not be worth the candle. Mr. Fell complained of the dirty condition of the lamps, and said that many of them were only giving 6 candle-power light instead of 16. Dr. Thursfield called attention to the increased cost of maintenance of the "Sunbeam" burner, the life of which was, he said, comparatively short, while the light became dimmer the longer it was burning. Mr. Barter-White hoped that care would be taken not to exceed the term—which expires on Thursday next—during which the experiments were to be continued without prejudice to the existing contract. The report of the Watch Committee was unanimously adopted.

Partnership.—Mr. W. Mackie, of Turk's Head Yard, Turnmill Street, has taken into partnership Mr. John Hicklenton Chalmers, the firm continuing the business at the same address as W. Mackie and Chalmers.

Electric Lighting in Pall Mall.—At a meeting of St. James's Vestry last week Mr. Keevil called attention to a huge smoke shaft being erected within 200 yards of Marlborough House, the Carlton Club, and St. James's Square, for the purposes of a new electric lighting company. He said he feared the Vestry did not realise the importance of the proceeding when a majority gave the concession for the erection of the shaft in such a central position. The vibration, with the smoke and steam of the works going on night and day, would seriously affect the comfort of the residents, as had been proved in Paddington, where the nuisance was so intolerable that rows of houses became vacant in the immediate neighbourhood of an electric lighting installation. He moved that the whole question of electric lighting be deferred until the new County Council had an opportunity of considering the subject. The motion was lost, and Mr. Keevil then said that he would convene a meeting of the ratepayers for the purpose of calling attention to the matter. A recommendation by a committee that an application by the St. James's and Pall Mall Electric Light Company for permission to lay mains from the central station of the company in Mason's Yard to Burlington Arcade be granted was carried.

Train Lighting in South Wales.—The Taff Vale Railway Company has for some time past been considering the question of improved lighting for its passenger trains, and the directors have just adopted the recommendation of their engineer, Mr. H. O. Fisher, to try electricity. The work has been entrusted to Messrs. J. B. Saunders & Co., electrical engineers, of Cardiff, who are the local agents for the Railway Electrical Contractors, Limited. Two trains of 10 coaches each are to be fitted and lighted experimentally for six months, and it is hoped that the new light will be brought into use early in January. It will certainly be welcomed by the numerous passengers who travel over this prosperous railway, and we understand that it will be fitted to all the company's trains if the experiment prove successful. The system will be the same as that on the Brighton, Midland, and Cheshire lines. Surely electric lighting would be a great boon to travellers using the Severn tunnel.

Action against a Telephone Company.—A claim for damages for £50 was made in the Cardiff County Court on December 6th by Mr. E. Jones, of Abergavenny, the owner of No. 160, Bute Street, Cardiff, against the Western Counties Telephone Company and the tenant of the house of Mr. Frederic William Crowther, for damages alleged to have been done to 160, Bute Street, through the telephone company having, with the tenant's consent, affixed a telephone pole on to the roof of the house. The evidence tended to show that the house had been damaged, and the parties agreed to a verdict for the plaintiff for £30.

American Bell Telephone Patent.—The Bell telephone people have received their first repulse in the litigation instituted by the Government to annul the telephone patents. The original suit brought by the Government in a Western court was dismissed on account of want of jurisdiction. An action was then brought in Massachusetts, in the United States Circuit Court, to set aside these patents, and the decision rendered amounted to this: Whether the patents were procured by fraud or not, the Government, in the absence of a statute to that effect could not have any patent annulled. This decision has been overruled by the Supreme Court, and the case has been sent back to the inferior court to have it tried on its merits.

The Compound-Winding Case.—The remaining evidence to complete this action runs to no less than twenty columns. In the interests of our readers we have throught it advisable to spread this over two issues, especially as judgment cannot be given before January next. Our report will be found far more complete and exhaustive than that of any other technical journal.

Halifax-Bermuda Cable.—At a meeting of the Legislative Council of Jamaica, held on the 16th of October last, the question of the subsidy granted to the West India and Panama Telegraph Company came under discussion. After some very bitter speeches with regard to the bad service and overcharges, it was eventually decided to grant the subsidy for six months only, enquiries to be made in the meantime as to the practicability of establishing a competing line. In this connection, the Governor, Sir Henry Norman, declared that he favoured the proposal of a line from Halifax to Bermuda and Wassau, and thence on to Jamaica, as being the most suitable route with regard to military and naval necessities.

City and Guilds of London Institute Old Students' Association.—A meeting of the O.S.A. will be held at the Technical College, Leonard Street, City Road, E.C., next Tuesday, at 8 p.m., when a paper will be read on "Charles Dickens and his Works" (illustrated by readings), by W. Beck, jun. This being the first meeting of its kind held by the association, the committee hopes that a large number of members and friends will endeavour to attend.

Where is It?—We observe in the last issue of an esteemed contemporary, devoted to the science and practice of electricity, an excellent illustration of that time-honoured puzzle: "Where is it?" The object to be searched for is the building owned by an electric manufacturing company, and its position is skilfully disguised by a capital view of a well-known hall whose architectural merit also serves to abstract attention from the real object. We hear it stated that these premises are on the point of being transferred to another company, and that the very large order for switches are for ——. Well, perhaps those who were so kind as to furnish us with the information which appeared in our last issue, will now tell us the destination of the 100,000 switches?

Fire Risks.—At a meeting of the Birmingham Insurance Institute, on Friday last, Mr. Frederick Brown, of the Wallsall Electrical Company, Walsall, delivered an address on "The Fire Risks of Electric Lighting." The lecture was made unusually interesting by the experiments given in explanation and illustration of the various special points of danger and security referred to by the lecturer, who had gone to the trouble of fitting up the room with electric light for the evening, the storage cells for which purpose were kindly supplied by Messrs. Elwell and Parker, of Wolverhampton. The address was fully appreciated by the members, who availed themselves to a large extent of Mr. Brown's courteous invitation for questions; and the meeting terminated with a hearty vote of thanks to the lecturer for his very instructive paper and illustrations.

A Menu.—A copy has been sent us of a menu "placed before each guest at a dinner given by a well-known electrician at Highbury," with a suggestion that it might be interesting to our readers. In one sense it might be interesting to our readers, for it is one of the most ridiculous efforts of the kind we have ever seen. It is a jumble of bad French and bad English, every dish having as an affix some electrical term or some name well known to electricians, applied without any regard for sense, rhyme, or reason. We will give a few specimens to show the utter absurdity of the compilation: "Caviare de Electriqué," "Filet de Soles Dynamic," "Pigeons au Chámpion de Ampère," "Turquie au Sauce Cellery, Telégraphic!" "Strawberry à la Telephonè," "Pine de Armature." We are reminded strongly of an Englishman we once knew, who, endeavouring to converse with a Frenchman, and finding that the latter could not speak English, being at the same time innocent of French himself, thought to bridge over the difficulty by pronouncing English words after the French style and prefixing French articles and prepositions. Needless to say, he did not succeed in his praiseworthy efforts to make the other understand.

Personal.—We have much pleasure in announcing that Mr. William A. Bryson, consulting electrical engineer, has taken chambers in 196, St. Vincent Street, Glasgow. Mr. Bryson was engineer and electrician to the International Exhibition, Edinburgh, in 1886; electrical engineer to the Royal Jubilee Exhibition, Manchester, 1887, and engineer and electrician to the Internation Exhibition, Glasgow, recently closed. With regard to this exhibition and Mr. Bryson's services Sir William Thomson bears testimony in the following words:—"Mr. William A. Bryson has acted as electrical engineer to the Glasgow International Exhibition of 1888 in a most thoroughly satisfactory manner. His initial advice and recommendations as to arrangements of all kinds have been found to be good and judicious. The work under his superintendence has been well done. In my opinion Mr. Bryson has proved to be of excellent capacity as an electrical engineer for practical work." Since his residence in Glasgow he has been appointed consulting electrician for the new Municipal Buildings and the City Hall and Bazaar, Glasgow; the New Public Library, Edinburgh; the Panorama of Bannockburn, Glasgow; the Panorama of Trafalgar, Manchester; the University Club, Edinburgh, &c., &c., and he has also acted as inspecting electrician to the S.Ss. *City of New York*, *City of Paris* and other important installations.

We understand that Mr. W. C. Mountain is about to sever his connection with the Gülcher Company to join Messrs. Ernest Scott & Co., one of the most progressive engineering firms in Newcastle-on-Tyne. It is five years since Mr. Mountain joined the Gülcher Company as manager of the dynamo department and engineer to the company, soon after which he took over the whole commercial management and was the means of introducing a large amount of business. During the last 18 months he has also undertaken the entire designing of all the dynamos and has entirely remodelled the Gülcher machine. It was also Mr. Mountain who designed the new alternating dynamos and transformers which are being supplied by the company for the lighting of the city of Wellington, New Zealand, and which have given very satisfactory results. It is probable that Messrs. Ernest Scott & Co., who are large makers of marine engines, will take up the manufacture of some new specialities, and in that case it is certain that they will find Mr. Mountain's experience of immense value to them.

The current number of *Science and Art* contains a biography of Mr. W. Slingo, principal of the Telegraphists' School of Science, an establishment of which we had occasion recently to speak in commendable terms. Mr. Slingo's nearly 20 years of service in the Post Office Telegraphs form a theme of great interest and the article is well worthy of perusal. The labours of the subject of the biography might be emulated with advantage by the rising young science teachers of the present day.

We learn with regret, says *Science and Art*, that Sir Philip Magnus will shortly terminate his connection with the City and Guilds of London Institute, of which he has been for several years the organising director. Rumours are rife concerning the strained relations extant between the various City companies who promoted this institution. One of the foremost of the companies has, we believe, withdrawn its annual subscription to the undertaking.

Our readers will be pleased to learn that Mr. William Grylls Adams, M.A., of St. John's College, Cambridge, Professor of Natural Philosophy at King's College, London, has been approved by the General Board of Studies for the degree of Doctor in Science.

How is this for High?—Two electric lifts will be employed in connection with the Eiffel Tower in the forthcoming Paris Exhibition. They will convey the public from the second to the third floor of the tower, a vertical distance of 492 feet. This heavenward journey will be traversed in five minutes without any intermediate stoppage and the car of each lift will accommodate 100 persons.

Marine Telegraph School.—We notice that the German Government has decided to establish a Marine Telegraph School, for the special training of men employed in the naval and coastguard services. The general system to be adopted is similar to that which has been found so advantageous with regard to the army.

Electrical Exhibition for Birmingham.—We are informed that there is to be an Electrical and Industrial Exhibition in Bingley Hall, Birmingham, next August.

Woodhouse and Rawson, Limited.—An extraordinary general meeting of the shareholders of this company is to be held to-day (Friday) at the Cannon Street Hotel, for the purpose of considering, and, if thought fit, passing a resolution to sanction and approve the sale of the undertaking and property of the company to a large new company now in course of formation, upon the terms set forth in a provisional agreement which will be submitted to such meeting; and also for the purpose of appointing a temporary auditor or auditors to the company.

Our Columns.—A long and cleverly written letter on the subject of vulcanised *v.* pure rubber insulation has reached us, but too late for insertion in this issue. A second communication on electrical engineering symbols must also stand over for a similar reason.

Dividends from Electric Lighting.—The *Allgemeine Elektrizitäts Gesellschaft* has issued its balance sheet. The paid up capital of this company is now 12 million marks. It has built 450 stations in Germany, supplying 110,000 glow lamps and 2,000 arc lamps; besides this, there have been installed 10,000 glow and 500 arc lamps outside Germany. The net profits are stated to be 1,073,796 marks, and a dividend of 7 per cent. was declared, a large sum being carried to the reserve fund.

Views of Civilisation.—The *Echo* has evidently been reading, and has imbibed the spirit of some of Sir John Pender's speeches. This is how it speaks of the International Cable Convention:—"Submarine cables are the veins of civilisation, and should be covered by international sanctions. We consequently regard with a thrill of satisfaction the fact that the British Government have announced the accession of the British Colonies to the International Convention of 1884 for the protection of submarine cables. This is another step in the slow march of bleeding humanity over a war-blasted world to higher and better things."

The Faure Accumulator Case.—The decision of Mr. Justice Kay in the Faure Electric Accumulator Company case is to be appealed against, and we hear, says *Money*, that notice of appeal has been duly served. This is what we anticipated, and it is altogether satisfactory. That decision is of such vast extent, that it is extremely desirable that the question of the illegality of directorial payments for the placing of shares should be authoritatively decided once and for all. Our own opinion on the point is known already; but "A Barrister" writes to us controverting it, and opines that Mr. Justice Kay was absolutely right, and that such payments, though generally made, cannot be legally upheld. If this be so, it is only one more instance of the absurdity of our company law; and as soon as it is decided to be so, the Legislature must be moved to reform it. In the meantime the Faure shareholders have to pay the piper; but they can console themselves with the reflection that they are doing good service to the public at their own cost.

Edison-Swan v. Holland.—The arguments in this appeal, the appeal, it will be remembered, of the Edison and Swan Company against the judgment of Mr. Justice Kay on the Edison incandescent lamp patent, were concluded last night, just prior to the rising of the courts. Judgment was reserved.

Reckenzaun's Tramcars in California.—The citizens of Sacramento, California, U.S.A., are enthusiastic over the successful introduction of Reckenzaun's cars on the Central Street Railway. The line, which was specially built for electric traction with storage batteries, is four miles long. The Sacramento papers are full of praise. One of them says:—"Ever since a few enterprising and energetic business men entered upon the construction of a street railway on which electric cars were to be used, the cry was heard on all sides that it never would be a success, and everything possible has been done by some people to belittle the efforts of the managers and throw cold water on the enterprise. The officers and promotors of the scheme had their day of victory, and received a perfect ovation from the populace as they passed through 'J' street on their elegant car."

Ransomes, Sims & Jefferies.—This firm has been awarded a gold medal for their exhibit of steam engines at the Melbourne Centennial Exhibition.

The Electricians' Directory and Handbook.—The 1889 edition of this publication is announced to be ready early in January.

Small Shears.—A useful little machine is manufactured by Mr. John Jardine, of Nottingham, designed for cutting off round rods without bruising the ends. Four sets of dies are fitted to the machine suitable for shearing rods of the following diameters: $\frac{3}{8}$ inch, $\frac{5}{16}$ inch, $\frac{1}{4}$ inch, and $\frac{3}{16}$ inch. Mr. Jardine has a number of these shears at work in his own factory, and finds them answer admirably.

Calvert's Mechanics' Almanack.—The 16th issue of this useful workshop companion is now published and is, as usual, full of varied and valuable information on a number of interesting technical topics. We cannot imagine a practical mechanic failing to find amongst its contents some item in his own line of a value far in excess of the small price at which the almanack is published.

Obituary.—We hear with great regret, but with only slight surprise, of the death of M. F. de Wolffers, who has, at various periods extending over the past five years, been a frequent correspondent of the REVIEW. The deceased gentleman, son of Baron de Wolffers, died in Paris on October 26th, of brain fever. It has never been our lot to meet with one so young who possessed so much literary ability, combined with such extensive technical and general knowledge, as M. de Wolffers, who, at one time, was almost a daily visitor at this office, and we venture to say that many of those who were his antagonists in the columns of the REVIEW, will learn with astonishment that he was but 19 years of age at the time of his death. He was possessed of a delicate constitution, never appearing to enjoy good health, and, as we have intimated, his early decease has not caused us much surprise. At the time of M. de Wolffers' death, his father was at Brussels, and his mother in New Jersey.

We much regret to learn of the sad and unexpected bereavement of a fellow worker in the field of electrical journalism. Mr. W. J. Johnston, editor and publisher of the New York *Electrical World*, is tolerably well known on this side, and we can assure him of the full sympathy of all who have made his acquaintance in the great loss he has sustained by the sudden death of his wife, who has succumbed to inflammation of the brain at the early age of 30 years.

Daft Electric Railways.—For the employment of artistic printing in setting forth their wares none can equal American commercial men. A choicely got-up little work illustrating and describing the Daft system of electric railways has reached us from the other side, and we are led to wish that our own manufacturers and commercial men generally would seek a higher standard of quality in the production of their catalogues and other business publications. Paper, printing and illustrations are in the case before us alike excellent. We have no doubt as to the ability of English printers to equal the work of their American fellows; but unfortunately they get too little encouragement in this direction. The poorest paper, the vilest cuts, and printing of a very inferior character are frequently considered quite good enough for trade catalogues and such like.

Peoples' Palace Technical Schools.—The first distribution of prizes and certificates in connection with these excellent technical schools, to which reference was made in our last issue but one, took place in the Queen's Hall on Tuesday evening the 4th inst., under the presidency of Mr. John H. Daniell, master of the Grocers' Company, the great building being crowded with the students and their friends. The report of the work carried on at the schools during the past session stated that excellent results had been achieved, and that the boys who entered for the science and art department examinations held in May, when the schools had only been in operation seven months, had passed with great success, a total of 3,716 students entering the various classes last year. In the evening classes which commenced for the present session on the 8th October, 2,230 students are already enrolled, the average attendance each evening being 500. The prizes were distributed by the Rev. J. E. C. Welldon, the Head Master of Harrow School, who expressed to the chairman as representing the Grocers' Company, the appreciation felt by those present and by the inhabitants of the East End of London of the splendid services rendered by that Company in connection with technical education. He also mentioned that he was glad to be able to say that even in the great public schools of England something was at the present moment being done in the direction of recognising the great value of technical instruction. The proceedings closed, after the usual vote of thanks, with a concert by the Peoples' Palace Choral Society and the Peoples' Palace Orchestra.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Australasian Electric Light, Power, and Storage Company, Limited.—The annual return of this company, made up to the 26th ult., was filed on the 7th inst. The nominal capital is £324,026, divided into 50,000 original shares of £5 each, 1,000 founder's shares of £5 each, 34,513 ordinary shares of £1 each, and 34,513 deferred shares of £1 each. The shares allotted are as follows: 23,985 original with £4 10s. paid, 6,000 original fully paid, 34,308 ordinary, and 34,308 deferred. The calls received amount to £106,521 7s., and the total amount considered as paid is £103,616, and the total of the calls unpaid is £1,411 3s. Upon 15 forfeited shares the sum of £60 has been paid.

Armstrong's Electric Light and Power Company, Limited.—At an extraordinary meeting of this company, held at the office of Mr. J. M. Bell, Palace Chambers, Bridge Street, Westminster, on the 12th ult., a special resolution was passed altering the articles of association, and authorising the directors to sell the secret process of the manufacture of "Electronite." The resolution was confirmed on the 27th ult., and was duly filed on the 7th inst.

City of Westminster Electrical Syndicate, Limited.—An extraordinary general meeting of this company was held on the 12th ult., when it was resolved that the capital be increased to £20,000 by the creation of 1,000 new shares of £10 each, such shares to carry a preferential dividend of £6 per cent. per annum. The resolution was confirmed on the 28th ult., and duly filed on the 5th inst.

Pilsen-Joel and General Electric Light Company, Limited.—The annual return of this company, made up to the 7th inst., was filed on the 10th inst. The nominal capital is £56,225, divided into 28,000 shares of £2 each, and 100 shares of £1 each; of the former 22,131 have been issued, and £1 8s. per share called thereon, and the whole of the latter are issued and are fully paid. The calls paid amount to £35,028 8s. Upon 5,869 shares forfeited the sum of £3,820 has been paid.

National Telephone Company, Limited.—The annual return of this company, made up to the 18th August, was filed on the 5th September. The nominal capital is £750,000, divided into 90,000 ordinary shares of £5 each, 15,000 first preference shares of £10 each, and 15,000 second preference shares of £10 each, the whole of which are taken up. The ordinary and first preference shares are fully paid, and upon the second preference the sum of £6 per share has been called up. The sum of £10 remains unpaid upon the second preference shares.

Lineff Electric Traction and Lighting Company, Limited.—The registered office of this company is now situate at 11, Queen Victoria, Street, E.C.

Caddy and Company, Limited.—The registered office of this company is at 1, Mansfield Road, Nottingham.

CITY NOTES.

The Swan United Electric Light Company, Limited.

The sixth annual report of the directors states that the business has increased on the Continent generally, and has resulted, after paying all current charges and making fair allowance for depreciation of plant and machinery, in leaving a credit balance of £8,332 1s., which the directors will recommend shall be carried forward.

The agreement with the Compagnie Continentale Edison, which was unanimously approved by the shareholders at the extraordinary general meeting, held on 5th June last, was also approved by the shareholders of the Compagnie Continentale Edison, and has resulted in the formation of the Compagnie Générale des Lampes Incandescentes, which has its seat in Paris, and who are erecting a factory with all necessary appliances for a large output of lamps to meet the established and growing demand.

The litigation as to the Swan and the Edison patents is still dragging on in Germany. The negotiations between the company and the representatives of the Edison patents in Germany have been dropped for some time, but the directors will avail themselves of any fair opportunity which may be afforded of reopening the negotiations with a view to a satisfactory settlement in Germany.

River Plate Telephone and Electric Light Company, Limited (in liquidation).—Holders of share warrants to bearer in this company are requested to send in their warrants forthwith to the liquidators, at the offices of the company, 53, New Broad Street, E.C., in order that the payment due thereon may be made before the liquidation is closed, otherwise application to the Court of Chancery for payment will be necessary.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending December 7th, 1888, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £4,903.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ending December 7th amounted to £5,917.

THE DUBLIN CORPORATION AND THE ELECTRIC LIGHT.

A special meeting of the members of the Corporation was held on December 5th in the Town Hall—Alderman Kernan, *locum tenens* for the Lord Mayor, in the chair.

Alderman Winstanley moved the adoption of the estimate required to meet the expenditure of the Finance and Leases Committee for 1889. He explained that the amount required this year was £6,795 13s. 3d., which represented an increase of £3,143 15s. 8d. on the amount required last year. The estimate, however, included £804 15s. to meet expenses in relation to a loan for £6,000 for electric lighting purposes, and a further sum of £1,220, being the estimated amount required for maintenance of the electric light. and the cost of obtaining a Provisional Order and licence.

Alderman Meade seconded the motion.

Mr. Shanks asked was it in order for the committee to try to obtain the funds necessary for introducing the electric light in this way without having obtained the sanction of the council.

The Town Clerk replied that the special committee in charge of this matter were authorised to take all necessary steps to give effect to the proposal in connection with the electric light.

Mr. Dennehy said there was no authority whatever for what the committee appeared to have done—namely, clothe themselves with the powers of the council, for the purpose of providing in the estimates for a loan for introducing the electric light.

Mr. Dawson, on behalf of Alderman Dillon (who was unavoidably absent), moved that the proposed loan of £6,000 be omitted, and that the estimates be reduced by £804 15s., and that £600 be struck off the item for maintenance of electric light, plant, &c.

Alderman O'Connor seconded the amendment.

Mr. Gill protested against the enormous expenditure proposed in connection with the electric light, especially as he was sure it would fall on the ratepayers. He knew a great deal more about the electric light than many members of the Corporation. The lighting of houses in Dublin by the electric light would cost from four to six times as much as it costs to light houses at present with gas. The Corporation should pause before they saddled the citizens with from £20,000 to £25,000. He believed the Gas Company were taking powers to supply the electric light, and he believed the undertaking would prove a heavy loss to the Corporation.

Mr. Doyle said it was a curious thing that Mr. Gill opposed the introduction of the electric light by the Corporation, while the gas company, of which he was a member, sought the power to introduce the electric light also. In fact, Mr. Gill's position was this—he was a shareholder in the gas company, and that company was desirous of introducing the electric light, without, as far as the Corporation knew, any opposition from Mr. Gill; yet he opposed any effort on the part of the Corporation to introduce the electric light. That was hardly consistent. He (Mr. Doyle) believed that the Corporation ought to have control over the lighting of the city.

Mr. Doherty said Belfast was the best lighted city in Europe, and it was lighted with gas under the control of the Corporation.

Mr. Healy said the burning of gas in some business houses was decidedly injurious to the people, and in various instances it was also injurious to stock. Business people, as a rule, were therefore anxious to get the electric light into their premises.

Alderman Mulligan said the charge per 1,000 cubic feet for gas in Dublin was enormous compared with the charge made in London. When that was the case, surely it was time that some other mode of lighting was adopted.

Alderman Flanagan said he could not vote for the report as he failed to recollect that the council delegated to the committee power to spend this sum of £6,000.

Mr. Robinson said the committee did not want the council to be bound to an expenditure of £6,000. They only wanted provision made that in striking the rates £6,000 should be provided for, so that the money would be at hand in case the council decided on the expenditure. The committee had no power to make contracts or anything of that kind.

Mr. R. Sexton pointed out that it would be a year before the money would be required, and he thought the motion premature.

The Chairman said it was not a fact that this scheme was attacked by gas shareholders. They were heavily rated in Dublin and £500 was a serious item. As a ratepayer he was very pleased that it was proposed to strike that off the estimate. He was not opposing electricity, for he would like to see the streets of Dublin well lighted, which they were not at present. In the street in which he lived, Harcourt Street, a man's life was in danger at nigh time owing to the bad light. The lamps were too far apart, and the Corporation were not willing to give money to the gas company to light the streets properly.

Mr. Robinson asked whether shareholders of the gas company would be at liberty to vote on this question?

The Chairman: The matter before the house at the present moment is promoting this estimate for electricity—the matter is electricity, not gas.

Mr. Robinson: As opposed to gas.

On a division 16 voted for and 16 against the amendment.

The Chairman said he had a second vote, and he would give it in favour of the amendment, which was accordingly carried.

Mr. Robinson then proposed that they present for £402 (instead of £804) to meet the expenses of a loan for electric lighting.

Alderman Byrne seconded the amendment.

Mr. Sexton said it was preposterous to attempt to press this burden on the ratepayers when Mr. Robinson and others admitted that the money would not be required for 12 months.

On a poll there voted for the amendment 16, against 16.

The Chairman gave a casting vote against the amendment, which was therefore lost.

Mr. Dawson proposed, "That the estimate be reduced by the sum of £1,404 4s. 9d. (viz., £500, half the sum af £1,000 maintenance *re* electric lighting, £804 15s. provision for loans for electric lighting, and £99 9s. 9d. proportion of cost and loss in collection), and with these alterations the estimate be adopted."

Alderman O'Connor seconded the motion, which was adopted unanimously.

AMERICAN NOTES.

By DAS TELEPHON.

THE most notable event in scientifically commercial circles of late is the imprisonment of Keely, of "*motor*" fame, for contempt of court, his release on *habeas corpus* after two days' residence in the common jail, and the announcement to-day that the differences between Keely and the Keely Motor Company have been compromised. In Philadelphia, on November 17th, on application of counsel, representing Bennett C. Wilson in his action against John W. Keely, the inventor, Judge Finletter, in the Court of Common Pleas, granted an attachment against Mr. Keely for contempt of court in the failing to produce the plans, specifications and general working model of his motor, as ordered by the Court of September 1st last. On November 20th Keely was released from Moyamensing Prison. He was taken out on a writ of *habeas corpus* issued by the Supreme Court, and was allowed to enter bail in $1,000 for his appearance on January 12th, when his case will be heard by the Supreme Court. His release was followed by a compromise which was publicly announced, on November 27th, as follows:—

"A meeting of the directors of the Keely Motor Company was held in this city yesterday, and it is said that all of the differences between Keely and the board have been compromised by the formulation of plans for an entire reorganisation of the company, which will be submitted to the stockholders at their annual meeting, on December 12th, for approval. The plans provide for a capital of $5,000,000 divided into 500,000 shares of $10 each, instead of 100,000 shares at $50 each, as at present. Of the stock 200,000 will be allotted the present stockholders, 200,000 shares will go to Keely, and 100,000 shares are to remain in the treasury."

Your readers will find in the above announcement a confirmation of what has been frequently put forth in these notes, that this great nation does *great* things. Only five millions of dollars for exploiting "a pig in a poke," alias the Keely motor, and only one million of dollars for the producer of the wonderful pig. I send you a report of a visit to Keely's workshop made by a friend for whom I had, after considerable intrigue, obtained an open sesame. The reporter writes:—

"I found the wonder-worker in an upper storey of the red brick house. He is about 6 feet high, strongly built, very muscular in form, slightly stoop-shouldered, and remarkably well preserved for a man 60 odd years old, who has spent 30 years in the most intense and incessant thought and labour.

"Mr. Keely says he does not create or generate any new previously unexisting force. He simply takes in one of his experiments the air we breathe and the water we drink, and by the concussion produced by certain musical sounds or notes he jars and disintegrates the air and the water, that is, destroys the cohesion existing between their particles and dissolves them into ether, thus setting free a force which is said to reside in the infinitesimal spaces that separate the ultimate atoms. In future he will discard the use of water entirely and operate only with air.

"On a movable wooden stand about 3 feet high, which resembled a truncated cone in front, but which was perfectly hollow, as could be seen from behind, was the strange piece of mechanism with which Mr. Keely is now conducting his researches. It was suspended from a metallic crane-like brace which projected from the top of the stand. This instrument or machine or mechanism or apparatus or whatever it is, Mr. Keely calls his 'compound disintegrator,' and there is probably nothing like it either in the heavens above or in the earth beneath. It is made entirely of metal, is perfectly round, and looks more like a wheel or pulley than anything else. It is about 2 feet in diameter with a rim some 6 inches wide. The whole thing is no bigger than a cheese box. In the centre of the apparatus at its hub, so to speak, from which spokes or braces extend to the rim, is a bore like that in the hub of a carriage wheel. Its diameter is about 1¼ inches. Scores of steel wire rods, about 2½ inches long, secured at one end and free to vibrate when struck or snapped, looking something like the tongues of a music box, are fastened to small metallic circular frames affixed to the body of the apparatus. Radiating from another and larger circular frame are 40 tubes or keys screwed into its rim, standing out like miniature cannon from the portholes of a fort.

"Innumerable wires in seeming confusion, keys, stops, cylinders, resonant tubes, prongs and metallic pieces of nameless shapes are all over and through the apparatus."

From great !! things to small things.

The smallest steam engine ever made has just been completed, after two years of labour, for the Paris Exhibition. It is composed of 180 pieces of metal, is a shade under three-fifths of an inch in height, and weighs less than one-ninth of an ounce. A watchmaker made it.

Several glass factories now cut the large cylinders of window glass by encircling the cylinder with a fine wire, which is then heated to redness by an electric current, and a drop of water being allowed to fall upon the hot glass, a perfectly clean cut is obtained. The old method was to draw out a fibre of white hot, semi-molten glass from the furnace by means of tongs and to wrap it round the cylinder.

The number of electric lights and their cost in the following named cities I gather from official reports of expenditures by the several city corporations:—New York has 1,435; Philadelphia, 756; Brooklyn, 1,014; Boston, 695; Buffalo, 996; New Orleans, 823; and Baltimore, 577. The pay for electric light is different, according to circumstances. Boston pays 65 cents per night for each lamp; Philadelphia, 50 cents; New York, an average of 34½ cents; Brooklyn, 45 cents; Buffalo, 45 cents; Baltimore, 50 cents; New Orleans, 34 cents.

Thomas A. Edison had an unpleasant runaway experience early yesterday morning, which came near having disastrous results. Mr. Edison held the animal well in the road for a short distance, when suddenly it swerved and the wheel of the buggy striking a large stone, the vehicle was overturned. Mr. Edison was only slightly injured, but the coachman was badly cut and bruised and suffered severe internal injuries. The horse ran half a mile, completely demolishing the buggy and bringing up in a pile of stones with a broken leg and other injuries. The horse was shot and put out of its misery.

Major Gregory and Captain Evans, of the lighthouse board, have just completed an inspection of the system of lighting the buoys in Gedney's Channel, New York Harbour, by electricity, and report it a complete success. It is, therefore, safe to assume that the system will be extended to other waters.

Philadelphia, *November 29th*, 1888.

COMPOUND-WINDING PATENTS.

KING, BROWN & CO. *v.* ANGLO-AMERICAN BRUSH ELECTRIC LIGHT CORPORATION.

(*Continued from page* 637.)

Wednesday, December 5th.

THE proof for the defence in this case was resumed on Wednesday before Lord Trayner, in the Court of Session, Edinburgh. Counsel remained as before. The cross-examination of Prof. Silvanus P. Thompson, which had not been concluded on the previous Friday, was resumed. Before the examination began, Lord TRAYNER intimated that the proof, if not finished on Friday, must close in the meantime on that day.

Prof. THOMPSON was then put in the witness box, and was cross-examined by Mr. GRAHAM MURRAY.

Coming to Varley's specification, you said in your examination-in-chief that as you read it Varley's first claim was not a claim for a machine, but for what you called a principle, which might be more accurately described as an arrangement for cutting out the bobbins. Is that so?—I rather meant a principle as embodied in the arrangement.

You gave us several illustrations of what you considered electrical absurdities in Varley's specification. I think I am right in saying that all these are the sequel, in your view, of what you consider the erroneous statement which begins at the top of page 7?—No, they are not in consequence of that.

Most of them are?—I think so; one certainly is not.

Which is the one that is not?—The passage I refer to is at the bottom of page 11.

That deals with another matter. But taking those which refer to page 7, as a matter of fact do those statements which you consider as containing what is an electrical absurdity affect the working of the machine?—The machine, of course, such as it is, works or does not work, quite irrespective of this described structure.

Is it not the case that the machine which is described in Varley's specification is a workable dynamo machine?—Yes, it is.

I suppose you would say that at its date it was a good machine?—I do not know that there would be any very much better.

What he does in relation to the bobbins is that at that point, which we have called for convenience sake the neutral point, he cuts them out of circuit with the armature?—Yes, his arrangement shows that.

That is the same thing as was afterwards done by Haddan in his specification?—Yes, in a different way.

In your view, the cutting of the armature out of circuit is a good thing?—Yes, for certain purposes.

The machine, by its arrangement, effects a good purpose, although in your view the description of the electrical consequences is scientifically inaccurate?—Yes.

Coming next to page 8, line 38, you said the statement there was not consistent with the series shunt arrangement?—Yes, not consistent.

I ask you, first of all, to take the first of the two sentences, which states that part of the electricity developed by the machine is diverted to maintain the magnetism of the soft iron magnets. That, I suppose, you will admit, is consistent with a shunt arrangement?—The language would lead me to think not.

Is it not true, then, say of a shunt machine, that part of the electricity is diverted to maintain the magnetism of the soft iron magnets?—Yes, it is.

And therefore it follows that the language is consistent with a shunt arrangement?—Yes, that follows, so far.

Is it not also true, speaking of the shunt part of a series shunt machine?—Yes, it is true.

Assume, for the moment, a series shunt machine; substitute for the first sentence these words: "Part of the electricity is diverted to the shunt." Now, is it not true of the series shunt machine to say that the remaining portion is used to produce the electric light?—Making that assumption, it is true.

Then how do you reconcile that with your former answer, that it is inconsistent with a series shunt arrangement?—Because I should then have to read in the last clause: "The remaining portion is used not only to produce the electric light, but to maintain the magnetism of the magnets."

Reading in these words, can that magnetism and the magnetism which produces the electric light and maintains the magnetism of the magnets be in any sense said to be diverted?—No.

If that sentence is defective, as you say, look at lines 45 and 46. There you will find that the greater portion of the electricity passes through the circuit of less resistance, maintaining the magnetism of the magnets, and producing the light. Does that not give you the very addition you want?—It gives me what does not exist in the first sentence, but it does not supply the want, and leaves the inconsistency where it was.

I will put it in another way. Supposing the first sentence and this latter one had all been written in one part, would that be consistent with a series shunt arrangement?—Yes, it would.

Then does your inconsistency come from this, that you find in two sentences what you expected to find in one?—I think it does resolve itself into that.

Look at the word divergent again, in which Varley says that part of the electricity is diverged to maintain the magnetism of the soft iron magnets. Is that not consistent with the principle of bifurcation?—We can now understand it so, but in those days it would not be so understood.

But it is consistent and appropriate, is it not, to describe bifurcation as divergent?—It is not usual, but it could be done.

Can you suggest any operations to which the word divergent is so appropriate as for bifurcation?—Yes; the operation which I understood by this when I read it was that it is not a portion of a single current that is bifurcated, but a portion of the electricity in the machine.

Just look at Haddan again for a moment, page 11, line 23, where he says, "I attain my object by diverting from external work a portion of the current of the machine and using it either along with or in connection with the rest of the current for the field magnets." Is he not describing bifurcation by that word?—Yes; for diverting part of the current.

But you have been particularly careful to tell us that in Varley's specification you read electricity as meaning current?—No.

In reply to Lord TRAYNER, witness said he understood "the electricity of the current."

Lord TRAYNER: I understood you the other way; I think Mr. Murray is right. Take Varley's specification, and read part of the electricity, as part of the electrical current developed by the machine, is diverted, and so on. What does that mean? If that was so would diversion be the consistent and proper language to describe bifurcation?—It is not the usual language but it would be consistent.

Mr. MURRAY: Upon line 38 of Varley what do you say electricity means there; is it electric current or electric energy?—The electricity of the currents.

I am entitled to an answer to my question. It must be one of the two things?—No, certainly not.

What is the intermediate thing?—Electricity is itself, and it does not necessarily flow along.

Lord TRAYNER: If it is not current, and is not energy, what is it?—Electricity of the currents. I understand this specification and the earlier one of Varley refer to an armature which had more groups of coils. Therefore there were currents that were produced, and part of the electricity was diverted to go round the field magnets.

Mr. MURRAY: Is it diverted in the form of a current?—Yes, I understand so.

If it is part of the electricity which is diverted, and if that is a current, do you not divert the current?—You divert part of the currents.

Lord TRAYNER: If the machine produced several currents, some of these may be used for one purpose and some for another?—Certainly, whereas bifurcation means the diversion of one current. The word divert is quite appropriate for bifurcation if there is only one current.

Mr. MURRAY: In every machine there are different currents, are there not? Each separate ring of the armature causes a separate current?—Yes, it may be so arranged.

And are they not got altogether into one?—In some machines.

That is the case with Brush's armature?—Habitually, yes.

You say that in 1876 the principle of bifurcation was not a thing known to any electrical workman?—That is so.

If workmen happened to know Wheatstone's shunt machine, he would have known of bifurcation?—But that was a series machine adapted for shunt.

Wheatstone's machine arranged for shunt?—Yes, with it he would know the principle of bifurcation.

If the workman happened to know Clark's patent, he would there find the principle of bifurcation?—I am quite sure of it.

Bifurcation was, of course, a very common thing in telegraphy?—Yes, quite common, and it was a very simple thing.

You said in your examination-in-chief that there was nothing inconsistent with Wilde's, or Ruhmkorff's, or Ladd's arrangement in Varley's specification. Look at that specification. Soft iron magnets there are, of course, the field magnets?—Yes.

Now, is not the idea of having the field magnet wrapped with two circuits of wire quite inconsistent with Ladd, Rhumkorff, and Wilde?—Oh, no.

Were the field magnets wrapped with two circuits in any of those three machines?—I think not.

Is it not the case that in those three machines the field magnets are only wrapped with one insulating wire?—That is quite right.

Is it correct to say, then, that there is nothing inconsistent in Varley with the arrangement of these three machines?—I think you will find in my language that there was nothing inconsistent, but that there was something supplementary, namely an extra wire.

There is no drawing, is there, in Varley's specification where you find the winding?—There is no drawing which shows two windings.

There is no drawing which shows a winding at all?—There are details in connection with windings, in fig. 6 of sheet 1, for example.

That is a winding of the armature, is it not?—Yes.

But surely I think you knew when I said winding I was referring to the windings of the field magnets?—I did not so understand you.

Lord TRAYNER: There is nothing in the figure showing the winding on the field magnets?—Only one, and that is of the most elementary description, where on fig. 17 of sheet 3 a dotted circle is introduced in the circuit.

Coming now to the question of the commutators, am I not right in saying that the drawing is inconsistent with a method of separate armature excitation?—Yes, it is.

Taking the old passage on page 8, do bifurcation and separate excitation exhaust the total possibilities of arrangements suggested by that passage?—I think I may answer yes.

Now, if you make a machine and follow the directions given upon page 8 at line 19—you have already told me that excludes the idea of separate armature excitation; is there anything left then except the idea of bifurcation?—The only possibility is absolutely separate excitement from another machine, but that is not hinted at.

But it is not consistent with line 38, which says "part of the electricity developed by the machine"?—Yes, I think so. I don't think the passage on line 38 refers to any particular machine.

Does it not refer to all?—I suppose it does.

Therefore it refers to the machine which has a commutator arranged according to the directions given on lines 19, 20, and 21?—Yes, if you put two windings.

Can you point to any part of the specification except that which shows separate armature excitation?—The only passage which occurs to me at the moment is the passage referring to the previous specification which had separate armature excitation.

Look at the drawings, sheet 1, figs. 3, 5, 6; these figs. are all inconsistent with separate armature excitation?—I do not think so.

Why not?—Because there is nothing whatever to show how the wires were united to the separate commutators.

But connections are shown?—The connections between the bobbins are shown in groups, but nothing further.

Don't you find in the description how they are connected?—Yes, in the description, half way down page 7.

Are they not also described at page 8?—No, that is referring to the subsequent machine, the two-fold machine. The armature of the two-fold machine is indicated by the figures, but the connections are not shown. There is nothing to suggest how separate excitation is to be done, except that fig. 17 shows grouping.

You will admit that figure is inconsistent with separate armature excitation?—It is a series excitation pure and simple, and it is inconsistent with separate excitation.

You said that a workman of the present day accustomed to the machines now in use reading Varley's patent would read it differently, that is as describing a series shunt machine?—I think he would now.

Do you reconcile that with your answer in which you say that the words themselves are inconsistent with a series shunt arrangement?—Yes, because the workman would read the knowledge of the present day into it and alter the meaning which he attaches to the language.

Varley has a circuit of greater resistance which he describes as always closed. Is that according to the patentee's idea?—Yes.

Into that circuit he puts a motor lamp?—Yes.

In the first place, it is optional, is it not, whether the motor is put in the circuit or not?—Yes, usually.

Secondly, is it not the case that, if the motor part of this lamp works properly, the circuit will always be closed?—It does not follow at all. It depends on the width of the teeth he uses. Witness was then asked a number of questions as to the mechanism of the motor, and he said that with the teeth employed it was impossible that the circuit could be always closed, but so far as the description was concerned it might be so. He had said in his examination-in-chief that Varley did not give any indication of the great difference between the resistance of the two circuits.

Brush did not give much more?—Yes, a little.

Seeing the drawing of an insulated wire, you cannot tell the diameter of the wire below the insulation?—Oh, yes, by experience you can. You know that on the fine wires, the insulation bears a larger proportion relatively than on thick wires. Consequently, when you see the insulated wires drawn, one thick and one thin, you know that one wire is very much thicker than the other. Witness afterwards admitted that there were insulations of different thicknesses.

You looked at Varley's machine manufactured by Siebe and Gorman. Is that machine constructed in exact accordance with fig. 17 of Varley's specification?—In general it is. It was not exactly, witness continued, because the connections were not there. Fig. 17 showed three sets of commutators and an additional arrangement for altering the circuit, and it showed the brushes connected together in a particular way. The brushes were not on that machine now. There were two wires going across which corresponded to the dotted line in fig. 17. In the absence of coupling he could not say there was anything on that machine that he could point to as inconsistent with the arrangement described on page 8, lines 38 to 48.

How many terminals are there on the main commutator of this machine?—There are two large screws, one at one end of the first of the three groups of the commutators, the other at the other end of the last group.

Which is just the place they would be for a machine that is to be used series-shunt?—Just at the place they would be on a machine to be used as series, as shunt, or as series-shunt.

But not in the place that they would be for separate armature excitation?—Probably not. It was not the case, witness held, that in order to make that machine work with separate armature excitation one would have to destroy or put away the connection existing between the separate sections of the main commutator. All that was wanted for that was an additional brush. That would be consistent with bifurcation—a small portion of the current. There were some other terminals to the machine besides the main ones. The three terminals on each side at the ends were fixed upon a subsidiary commutator which was meant to provide for an alternating current.

And is, therefore, a separate arrangement from the main commutator altogether?—An adjunct to it. It was very likely, witness admitted, to find the couplings broken and disjointed as they were here, on the machine coming out of a store.

If you were told as a matter of fact that this machine was worked with an arc lamp, such as this Serrin lamp, and it was noticed that when the lamp was burning the magnetism of the machine gradually increased, what would that indicate to you?—That there was a coil in the circuit on the magnets.

In other words, that the machine was series wound?—That it had certainly a series coil.

If, on the other hand, you were told that when the lamp was out there was still magnetism in the magnets, as indicated by sparking, what would that show?—It might indicate that there was some residual magnetism, or it might indicate that there was excitation from some separate source, either internal or external, or it might indicate that there was shunt winding.

Sparking would not indicate residual magnetism if the sparking went on for some time?—Oh, yes.

I thought the great object of these devices was to overcome the difficulty that residual magnetism was exceedingly weak?—You want more than residual magnetism for the maintenance of your permanent field, but there is enough to give you sparks at the commutator.

Do you think that is the case with a wrought iron machine?—It is not so likely.

This is a wrought iron machine?—I don't know.

If you were told that there was continual sparking of the brushes of the commutator, do you think that would be due to residual magnetism?—It would depend upon how much sparking there was.

Is it not much more likely to be due to one of the other two causes?—Either of them would produce the same effect.

And would be more likely to produce the effect than residual magnetism?—Not more likely.

Take the second cause, separate excitation; so far as this machine is concerned you have said that if the commutator was arranged as at present separate excitation was out of the question?—Yes, absolutely.

The assumption I wish you to take is this—that this machine was worked with that lamp, that it was observed when the lamp was lighted the magnetism of the machine was increased largely, that when the lamp was not lighted there was sparking at the brushes, and that the commutator was arranged as at the present moment. Does that not point straight to a series shunt arrangement?—Not unless I make the assumption of the connections between the commutator and the coils.

But if you make that assumption?—Yes.

Taking Varley's lamp with the motor put in the circuit of greater resistance, assume that Varley's machine was arranged as a pure shunt. If the contact of the carbon in the lamp was good, and the resistance was consequently small, that would induce the greater portion of the electricity to flow through the electric light circuit?—Yes, it would.

Would that not leave rather little electricity for the magnetisation of the magnets and working of the motor?—Yes.

Assume that Varley's machine with the lamp was arranged pure series, and assume that the carbon disc employed was the one used in fig. 24 with the grooves along its periphery. If there was a hitch in carbon making contact with carbon in crossing one of these valleys, the electric circuit would be opened?—Yes.

And that being so, would not the whole thing stop?—The magnetism would temporarily go down.

I put it to you; would it not be the case that if a bad contact was made the circuit would be opened and the motor would cease?—Yes.

But would not both these disadvantages be got over by the series shunt machine?—Yes; in that case whenever the lamp went out the current would go hard, and *vice versâ*.

Is not the series shunt arrangement the best that could be devised for that particular lamp?—It shares the advantage of the separate circuit arrangement.

Coming to the question of the commutator, do you represent that according to your view the only invention disclosed and claimed by Brush was the metallic insulating segment so far as it consisted of giving the insulating segment a cylindrical surface for the purpose of giving cylindricity in wear, and so far as it provided a means of insulation?—These were points.

Look at page 10,—"I desire it to be understood that the insulators, T, may not of necessity be metallic. They may be of any non-conducting substance, or if desirable, by mere spaces." Take the alternative of the insulating segment being a mere space; you cannot construe that as a claim for a wearing segment?—That applies to a particular case, where the segment is a thin one.

Taking the case of a space, the only advantage you have is the insulation at the neutral point without any advantage to the wearing surfaces?—Yes, but that is not new. It was new to introduce an insulating piece instead of leaving a space. Every commutator had a gap between the ends of the working parts. What Brush tells you there is,—"I claim the invention of putting on an insulating metal piece, but you need not use it when the space is small." Brush's plan of cutting out the bobbins at a particular time of the revolution was not new.

The Dean of Faculty, interposing, explained that that matter was in division one, which was not claimed. The claim dealt with nothing more than the metallic wearing segment.

Mr. Murray: If it is consistent with claim 6 to have in place of insulating segment, T, a gap, will you point to any place in the provisional specification where any idea of that is disclosed?—I read that he had a gap at the one side, but not at the other. At one side he left a gap where the sides were sufficiently close; at the other end he put in the segment, T. In reply to a further similar question, including a reference to page 10, witness said there was no point where the idea was disclosed; it was merely indicated that there was an insulating hub. Regarding the Manchester commutator, the use of the shaft as an electrical connection was equivalent to a wire. In a commutator with eight wires, there would be electrically no difference if seven wires were used, and the shaft of the machine for the eighth. Still, it was better to insulate every wire going to the commutator, while the shaft was in metallic connection with its bearings, and there was therefore a leak. So far as the wearing segments of the commutator were concerned it made no difference if they were easily removed. The insulation of the Manchester commutator was by a piece of ebonite; he did not like to call it a hub.

You have seen the commutator of Varley's machine, and the part taken off. Don't you think that the segments there are detachably attached?—They are rivetted on.

Is it not partly a rivet and partly a screw?—They look like screws that had their heads rivetted over.

Is not the worm of the screw only at the lower end?—Yes, I think so.

The bushing of the rivet has been of the slightest description?—I cannot tell.

But assume you knew that; would it not have been in the power of mechanical appliances to take out these rivet-screws?—Certainly; by chopping off the heads of the rivets.

If the bushing was very slight and they a bit worn, you would not need to do that?—That is a question of degree.

If the wearing had come down below the bushing, then all you would have to do would be to put a nick in the head of the nail and screw it out?—The wearing would not get so far as that before the segment would fly off.

Lord Trayner: Then they would be very easily detachable in that case.

Mr. Murray: I thought one of the great points on your side was that the screws being radial, the segment was kept on by their direction?—I did not say so.

Four screws and those radial, would that keep it on?—That depends on the angle.

And if at a proper angle?—That depends on the pitch. (Laughter.)

Lord Trayner: Mr. Murray, try and land your fish; I am tired of your playing him so long. (Laughter.)

Mr. Murray: Assuming that the construction was known, could they have been taken off easily?—That depends upon the state of the machine and the appliances at hand.

Lord Trayner: They could not do it with a quill pen. (Laughter.)

Witness: No, nor with a screwdriver.

Re-examined by the Dean of Faculty, witness said that in the chronological list of previous machines he had put the shunt before the separate excitation machine solely in respect of Wheatstone having in 1867 suggested such an arrangement to the Royal Society. The tendency to maintain constant potential, which he had said existed in a well-constructed pure shunt machine, was enhanced by the use of a series shunt arrangement. A well-constructed shunt might work better than a badly constructed series shunt. But in machines of equally good construction, the series shunt was certainly preferable. He thought Brush indicated that in his specification. When he said there was nothing inconsistent with Varley's description on page 8, founded upon, with Wilde's, Ladd's, and Ruhmkorff's arrangements, he referred to their mode of diversion, and to their employing some windings of the armature separate from the others to provide current in a separate circuit. When he had spoken of Varley supplementing these arrangements, he had referred to what Varley did with the current after diverting it. The word circuits in Varley's statement would lead one away from the idea of bifuration entirely. Page 7 provided for separate armature excitation in the case of the number of bobbins being in excess. Varley's machine could be easily altered so as to admit of that.

John Perry, Professor of Applied Mathematics and Mechanical Engineering at the City and Guilds of London Technical College, Finsbury, was examined by the Dean of Faculty.

Have you designed, constructed, and used dynamo machines and many other kinds of electrical apparatus, for about 18 years?—Yes; more than that for certain instruments; dynamo machines for 10 years. I have read and studied Haddan's specification, with the relative drawings and the various disclaimers, with the view of giving evidence with reference to the various objections which have been taken to the utility and novelty of the invention, and the sufficiency of the description in the specification.

We have been told that at the date of Brush's patent there were in use four kinds of dynamo machines—permanent magnet machines, machines excited from a separate source, series wound machines, and machines excited by a separate armature, or otherwise, from a separate source within the machine?—Yes.

Had the shunt arrangement been also disclosed by Prof. Wheatstone?—It was not disclosed to ordinary electricians or workmen. It was not known to me till long after the date of Brush's specification.

Taking these various machines, would you tell me what was the objection to the permanent magnet arrangement?—For such purpose as Brush designed his machine, or for incandescent lighting at the present time—for both these purposes it would be defective, on account of the potential falling when work to be done became greater.

As to the machine that had its magnetism excited from a separate source?—The objection there is almost exactly the same.

In point of fact, those two kinds of machine have gone pretty much out of use?—Yes.

Take, next, the machine which had its magnetism supplied from electricity produced within the machine from a separate source?—The fault of that was pretty much the same as the fault of the permanent magnet or the outside excitation machine. There was also an element of awkwardness and costliness. That arrangement has also been pretty much superseded.

But at the date of Brush's patent was the series machine largely used?—It was.

What were the defects of the series machine as used at the time of Brush's patent?—In the series machine, when the work to be done increased, the potential increased.

Hadn't it a tendency also to fall too easily?—To fall too easily, of course, in the event of any break in the external circuit.

Or in the event of the current being very low?—Yes; it would no longer excite itself.

What were the defects of the shunt arrangement?—That had the opposite sort of defect to the series machine; that is, as the work it had to do increased the potential fell.

Were these serious defects applying to each of these machines?—Most serious for such purposes as incandescent lighting and electro-plating.

Then, Brush's arrangement was what is now known as the series-shunt arrangement?—Yes.

Tell us the merit and utility of that arrangement as compared with the series and the shunt machines?—What we want is a machine whose potential will keep fairly constant while the work to be done is increasing. In the series machine we have the potential increasing, and in the shunt the potential diminishing as the work increases. Brush had a combination of these two machines; that is, in the two kinds of winding on his machines, and the one winding compensated the defects of the other.

Was that in your opinion a valuable improvement?—An exceedingly valuable improvement.

Did Brush purport, as you read this patent, to give directions for making an absolutely constant potential?—He does not mention potential at all. As a matter of fact, what he wanted was a fairly constant potential. The word potential was not known to electricians or workmen at that date.

You never get absolutely constant potential?—No.

To approach to constant potential is necessarily a matter of degree?—Yes.

Do I understand you to put it that Brush's invention lay in supplying the means of producing the compensating effect which tends to constant potential in a greater or less degree?—Yes.

Is it at all correct to suppose that the utility of the series-shunt winding depends on the attainment of constant potential?—No; approximate constant potential.

Is the compensating action the necessary consequence of winding the magnet with two wires of different resistance?—Yes; the wire of higher resistance being the shunt.

Has electro-plating since the date of Brush been practised both with the shunt and with the series-shunt arrangement?—Yes.

And for electro-plating has either of these methods certain advantages?—The series-shunt arrangement seems to me very much more advantageous.

But either has certain advantages in electro-plating?—I don't know that the shunt arrangement has any advantage over the other.

For practical purposes is the danger of reversal greater in the one arrangement than in the other?—It is slightly greater in the series-shunt than in the shunt machine.

Has that been found to operate against the series-shunt machine in cases where absolute freedom from the possibility of reversal is desired?—It has never been found, I believe, a practical difficulty in electro-plating.

Mr. Brown was examined here the other day and mentioned an instance of reversal of polarity which occurred in a series-shunt machine in his workshop. Have you had your attention drawn to that part of his evidence?—Yes.

Would you tell me whether Mr. Brown's evidence is in any way against your view of the utility of the series-shunt machine?—Not in the slightest. What he describes there—I do not know what may have happened or what he ought to have said ——

His Lordship: You will assume what he said is printed there.

Witness, proceeding: That would have happened with any dynamo machine standing still. The engine had stopped and it was very foolish not to have broken the current.

What happened in Mr. Brown's machine must have happened in any case?—Yes, if what happened is what is printed there.

Kindly take it that it is so. With respect to the sufficiency of Brush's description have you any doubt that the directions in the specification are sufficient to enable a workman to carry the invention into effect, and to construct a series-shunt machine which would tend largely to constant potential?—I have no doubt whatever. He describes both long and short shunt, the only two varieties known, quite plainly in the drawings and print.

Is the description, so far as applicable to the series-shunt winding, particularly clear and full?—Yes, and fully illustrated by drawings.

Is it possible to give directions which would enable a workman to make every type and produce electricity at an approximately constant potential?—I do not think it is possible to draw up a specification which would give these instructions.

So that, even at the present day, unless you were simply repeating an old machine on the same lines, you would require a certain amount of experimental winding in order to get at your constant potential or approximation to constant potential?—The word experiment sometimes is taken as something which leads to invention ——

His Lordship: We know that. Use the word trial.

The Dean: Trial. Taking the question so, what do you say?—Yes, it needs trial and measurement.

Have you now got certain formulæ that diminish the necessity for the trial and measurement in respect to certain classes of machines?—Yes, the formulæ are really for the purpose of more easily describing to the workman what he ought to do.

Have you examined the specification in order to ascertain whether Brush describes bifurcation as the method by which he divides his current?—Yes; the print and the drawings most distinctly say bifurcation.

And exclude absolutely excitation from a separate source, internal or external?—Yes.

Coming to the question of anticipation witness said he had read Varley's various specifications and also the communication by Professor Wheatstone. Wheatstone converted a series into a shunt machine.

Was it a shunt machine in all circumstances, or only when the outside circuit was open?—Only when the outside circuit was open.

It was not a shunt machine when the outside circuit was closed was it?—I really do not know. I have not figured it out. It would be very easy to figure it out.

What I wished to ask you was, did that communication so far as you know lead to the manufacture of a single shunt machine?—No.

And except so far as eminent scientific men were concerned, did it add to the knowledge of electricians on the subject?—No; unless the scientific man had a very good memory he would have quite forgotten.

Was the idea put into any useful or practical form, or was it a mere suggestion which required to be worked out?—A mere suggestion which required to be worked out.

In point of fact, did eminent scientific men so late as 1879 indicate ignorance of Wheatstone's suggestion?—Yes. There were a great number of publications and important discussions on dynamo machines before 1879, and in the printed record of these discussions I do not believe there is one mention of shunt winding.

Was any machine ever made according to Clark's specification?—I have never heard of it.

What were the dynamo machines which were known and used at the date of Varley's patent, apart from permanent magnet machines and the machines excited from a separate source?—The series machine was the one most used, and there was also the Wilde machine which excited its field magnets from a part of the machine.

Were there also machines on the same principle, also much used, introduced by Rhumkorf and Ladd?—Yes.

Was there any in use known to workmen where the electricity was divided except Wilde's, Ladd's, and Rhumkorff's machines?—I do not believe there was any in use.

Do you find in Varley's specification of 1876, in any part of it, a disclosure of the series shunt arrangement?—No.

Would you tell me what, in giving that answer, you take to be the essential characteristics of the series shunt arrangement?—First, the whole of the electricity generated is employed at all times to maintain the magnetism of the magnets. Secondly, that electricity divides itself between two circuits—two windings of the magnet. Thirdly, in its method of division; there is a current bifurcated.

All these are equally essential points?—Yes.

Take the first sentence in Varley's specification in the passage founded on page 8, line 38 to 40?—He speaks there of part of the electricity developed by the machine is diverted to maintain the magnetism of the soft iron magnets and the remaining portion is used to produce the electric light. That is inconsistent with the series shunt machine.

Going on to the next sentence, he says "There are several well-known ways of doing this." Does that contain or does it exclude any suggestion of bifurcation?—Most certainly it excludes any idea of bifurcation.

Why?—The shunt machine was not at all well-known—the idea of the shunt was not at all well-known. The only well-known way of dividing the current was not by bifurcation. Varley himself used a method in 1867 which was not by bifurcation.

Taking the passage as a whole, and reading on, I ask whether any part of it appears to you to disclose a series shunt arrangement?—Well, you would have thought, if it had been written in the present day, the latter part discloses it: only the first contradicts.

Taking it as addressed to people who had the knowledge of 1876, would you give me your reasons for saying that the passage taken as a whole is not, in your view, a disclosure of the series shunt arrangement—I mean such as would enable an ordinary electrician to construct such a machine?—In the first place it is inconsistent with itself. The first sentence is inconsistent with all that comes after. In the next place, if we take out the inconsistency, we shall find that the whole passage is perfectly consistent with separate circuit excitement of the magnets, And bifurcation was not mentioned once. In one place, in lines 42—3, he speaks of two distinct circuits, which is against any idea of bifurcation.

And points towards an improvement on the Wilde arrangement?—In fact points to his patent of 1867.

Is your view confirmed by a reference to his patent of 1867?—Yes.

His patent of 1876 professes to be an improvement on his previous patent?—Yes.

What do you find confirming your view?—In the 1867 patent, lines 19 to 28, he describes two windings, one going from a separate portion of the armature.

And to any workmen who read his specification as a whole, and went back to the previous specification, that would be the only description he would find of a source of excitation?—Yes.

Would the fact that one part of the specification is difficult to reconcile with another be seriously misleading to an ordinary skilled workman?—Most certainly.

Speaking for yourself, do you think you would have been readily misled by the inconsistencies in the specification?—I am sure I should, but it is very difficult to me with my present knowledge to think myself back to 1876. We have learnt everything since 1876.

As to the inconsistency of Varley's description with the separate armature arrangement, we have been told that in other parts of Varley's specification that arrangement is excluded. Taking the passage on page 8, line 20, it makes no reference to any particular drawings?—Yes. It is really describing a particular kind of machine, and it only refers to that machine. It speaks of a machine in which you have three coils in a group.

And where you have your number of commutators just equal to the number of bobbins forming each group?—Yes; these drawings exhibit one of those machines, and it is distinctly a pure series machine.

Supposing that the direction here is to join up the commutators as shown on fig. 17, I ask whether this passage, read in connection with the text has, in your opinion, any bearing on the question whether separate armature excitation is excluded?—No bearing whatever.

And the second armature excitement might be excluded there and not excluded generally?—Yes.

If you go back to page 7, line 15, is it not the case that you find provision for having any number of commutators?—Yes, as many as bobbins.

And does that provision admit of the separate armature excitation?—Easily.

Is it the case that the passage on page 20, taken by itself, points to a series shunt arrangement?—No.

Is that passage, reading it as we have it there, quite consistent with an excitation from a separate internal source?—No; it is a simple series machine he is describing.

The description here is inconsistent with the series shunt arrangement and with the excitation from a separate source?—I do not think I go quite so far as that. It is inconsistent with the series shunt machine. He is simply describing a series machine.

His Lordship: He does not describe a series shunt; he describes something which might be made into a series shunt?—Yes.

The Dean: Or a separate excitation machine?—Yes.

In fig. 17 the commutators are connected diagonally. Does that point to a series shunt arrangement?—No; it points to a series machine.

Have you read Varley's specification as a whole in order to say whether it is intelligible or was likely to puzzle and mislead an electrician?—It is very misleading; there are many absurdities. A very large portion of the specification, devoted to describing how the machine is made, involves these absurdities. The rest of the specification relates to a lamp which has never been made, and which if it had been would have been a very bad lamp.

You have seen a communication to the Royal Society by Mr. Cromwell Varley. You have seen a drawing made of that arrangement?—Yes. It is a very fair representation of Mr. Cromwell Varley's specification.

Now does Cromwell Varley's description bear any resemblance to the series shunt arrangement?—None whatever.

Would you imagine any person of electrical knowledge mistaking the one for the other, or apprehending that the one might anticipate the other?—No.

Coming to Varley's machine; have you examined that machine?—Yes; but I have not been able to examine it with very great care. I have gone over it as carefully as I could without taking it to pieces.

Can you say from the appearance of the machine whether it was constructed for working or for experiment?—From the number of binding screws close along the base I should say it was constructed for experiment.

From these binding screws could it be coupled up in any way desired?—Almost any way. It could be used as a shunt machine, or a series machine, or a double shunt machine, or coupled up to make a series shunt machine.

Lord Trayner: It seems to be a very remarkable machine.

The Dean: We are told that as it stands now you could not work it on the separate excitation system. Would there be any danger in altering the connections?—I do not see any.

You have examined, I believe, the models which were put in by the pursuers, as made in accordance with Varley's specification?—Yes.

Shown a model, witness said it differed in many respects from Varley's machine.

Do you think that models made from Varley's specification, at the present time, are really useful in showing what Varley's specification meant in 1876?—No.

Is the state of electrical knowledge quite different now?—Yes.

Has the excellence of the mechanical construction of the Brush commutator contributed largely to the success of their machines?—Yes.

Have you examined the commutators the use of which is alleged to interest the claims of the pursuers?—Yes.

Do these appear to you to anticipate the Brush commutator?—No.

Take the coiled commutators first. Are all Brush's wearing segments on the hub?—Yes, one of them.

What do you say of the Varley commutator?—Well the wearing pieces are not detachably attached; they are put in by a screw the head of which is rivetted over, which makes it exceedingly difficult to detach it, and in addition the head of the screw is very near the surface, so that a very slight wearing away would take it off. In Brush you have this carefully guarded against.

Cross-examined by Mr. Graham Murray: You told us the defects of the various classes of machines, and of these you gave us the defect of the separate excitation within the machine itself from the armature, that they were costly and awkward. Now wherein did the awkwardness consist?—If you needed a separate commutator in place of collecting your electricity. That is not so easy as in modern machines.

I am referring to all machines which have commutators which collect the whole current instead of one collecting one part of it and one the other. Now the defect, on the other hand, of the series machine is said to be that the magnetism occasionally had a tendency to fall to zero?—Yes.

As between the various uses of these different machines, first of all you have told us a little about electro-plating and then you said two things I should like you to explain, first you said a shunt machine could reverse its polarity, and secondly, how is it that what happened in Mr. Brown's works, as detailed by him in his evidence, if any machine had been used instead of a series machine, would you kindly tell me how the polarity could be reversed?—I don't understand.

Suppose a counter action set out by the electro-plating bath, that is how it began?—Yes.

That current then invades, if I may so put it, the outer circuit by going up, the wrong way and coming out the outer side it reaches the armature. Starting from the armature does it not go through the shunt circuit, and therefore does it not maintain the polarity of the magnets, which is in the same way as the shunt circuit?—Certainly.

Then how can it reverse the polarity?—When you have 300 degrees the resistance in your shunt that you have in your armature. If you have a powerful armature, the current passing through the wires of the armature itself produces a field which is almost in opposition to a field produced by the field magnets. I have only heard of such an experience occurring; it is quite exceptional.

Would not that even be only the case if you moved the field magnets?—No; if you have the brushes used in the usual way, I am perfectly certain I am right; I have heard of its occurrence.

Well, it practically comes to this, that there is not the slightest fear of a shunt reversing?—Practically that is so.

You have said that the result of making a machine in accordance with Brush's specification would be to make a machine which would tend to give you a constant potential?—Yes.

Might it not be the case that you might make a machine according to Brush's specification without securing a potentiality of that degree of constancy which is practically necessary for the modern development of incandescent lighting?—I could not; but a workman might or might not:

Would a workman, who had nothing but Brush's specification, make a machine necessary to produce that constant potential?—It does not necessarily follow. We might make a machine which would not produce the approximation necessary for incandescent light.

Do you think there was patentable matter left to the getting of constant potential after Brush made his discovery of compound winding?—No, I don't think there was.

Do you know that there were a great many devices started for regulators with the view of securing constant potential?—Yes.

You have said that Brush clearly disclosed the method of bifurcation of a current by means of splitting the wire?—Not in connection with dynamo machines.

No, I am not putting it in any connection at all. That is quite common in electrical science?—Yes.

When you have a current that is bifurcated, do you think that divert is an appropriate word to describe the taking away of a portion of the current by one of the bifurcations?—Yes.

And Brush so uses it?—Probably.

Siemens, you said, took out a patent for shunt winding. Have you got it?—No.

Siemens also read a communication about the same time—in 1880?—That I listened to at the time.

In that he clearly treats shunt winding as a thing already known?—Well, that was not the impression I got at the time. I know that his paper startled everybody.

Every book on the history of dynamos, I think, mentions shunt as having been discovered by Wheatstone?—Every book since 1882. No book, probably, written before 1879.

Since our attention was particularly drawn to shunt by Siemens, do you think it is an accurate description to say that part of the electricity developed in the machine is diverted to maintain the magnetism in the soft iron magnets?—Yes.

But it is equally appropriate to use the word "divert" to a case where you are bifurcating the current?—Not bifurcating the electricity though.

What does the word electricity mean, is it energy or current?—It is not energy.

Lord Trayner: Well, what is it? It may mean current or currents.

Mr. Graham Murray: Well, if part of the electric energy is diverted it is then a current or currents that is diverted. Is not this a perfectly proper way of describing bifurcation?—Yes.

Does your evidence come to this, that Varley was describing nothing at all, that the passage where he explains his system is consistent with no arrangement?—He is trying to describe something that was in his mind and I cannot find it out. Nothing is consistent with the whole passage.

He says "part of the electricity is diverted to maintain the magnetism of the soft iron magnets." That is true of the shunt portion of the series shunt arrangement?—Taking that portion by itself it is true.

The next portion "the remaining portion is used to produce the electric light," is that not true of the portion which in the series shunt arrangement is not used in the shunt, but is used in the series?—No, it is not the remaining portion because it has been maintaining the magnetism.

You have already said this is an accurate description of the function performed by the electricity which goes for shunt in the shunt series machine?—Yes.

Now as to the remaining portion of the electricity, is the whole of the electricity diverted by the machine the portion which has been used in the shunt circuit?—No.

Why not?—He says "part of the electricity." In the series shunt machine all the electricity is used to maintain the magnets.

But is it not diverted to maintain the magnets?—No, it is not diverted.

You have conceded that what is described is an accurate description of what happens with the portion of electricity which is devoted to the shunt in the series shunt machine? Well, if I substitute the words "So much of the electricity is used in the shunt," is the remaining portion, not the whole of the electricity except what is used in the shunt?—Yes.

Now, is it not true to say that the remaining portion is used to maintain the magnets?—If the first portion is only what is used in the shunt.

Well, can you construe that the portion which is used in the series to maintain the magnetism is in any way diverted?—No.

That being so it is true that the portion used in the series, which is the remaining portion, is used to produce the electric light?—Yes.

I suppose you will also concede that a machine made with commutators, so long as the commutators were allowed to remain in the form described, could not work without separate excitation within the machine. I wish you to suppose that a machine has been constructed and a commutator given to it of the form described. We now proceed to the winding of the field magnets of that machine. The only description of winding field magnets is that at line 38. Would it not be appropriate for Mr. Varley to wind his machine which he has made with that particular commutator, according to the method disclosed by him?—He might do so. It is appropriate for Mr. Varley to make a machine with a commutator and to wrap it or wind it in such a way that you would not have a pure series machine.

Leaving that commutator untouched it would not be possible to have separate excitation within the armature of the machine?—I am not sure, I have not gone into it. I don't think it would be a machine capable of self-excitation within the armature.

Now we have excluded self-excitation and pure series winding will you please tell me what you have left except series-shunt?—For a machine made as described in lines 19 and 21, and the field magnets wound as described nowadays, we should say it must be series-shunt. I do not know what would be said at that time.

You said fig. 17 showed the winding; does it do more than show the place where the winding was to be—I am speaking of field magnets?—It shows the electro magnets in the machine; there is only one dotted line.

That dotted winding does not adopt the notation of the usual winding at all?—It shows that the winding is to take place by one circle. There is nothing absolutely showing a second or shunt circuit.

This is a picture of a commutator, and it does not show the winding of the magnets?—Yes, it does; it shows one wire around the magnet. The dotted complete circle shows the winding of the magnets. It is not a notation to indicate the winding at all.

Is it not there to show that it is not commuted?—It has been commuted; it has come from the commutator.

It is not, however, commutated again?—No, I do not think it is put there for that at all.

The existence of the line shows that?—No, it shows that it is a series machine around the electro-magnet. It is not necessary to show the position of the magnets. We want to show where the current is going, and we show it is going round the magnets.

You gave an opinion as to what you call electric absurdities in Mr. Varley's patent; do these absurdities in any way affect the construction of the machine as disclosed in the specifications and drawings?—Yes. As to the reversal during the passage of the bobbins from No. 3 position to the No. 1 position, the machine would not work or give any current if that were carried out. If a man made a machine so as to reverse this current at that place, it would not work. This description induced a man to arrange his commutator for the reversal.

Does it do anything more than cut out the commutator connection at a certain portion of the revolution?—There is a distinct instruction to reverse your current at a certain point.

He does not tell you to reverse your current at a certain point, but he tells you to work your machine, and then he says: "reversal does take place at a certain point." Assuming you are right, and the reversal does not take place, does the machine not work perfectly well?—If his descriptions are otherwise perfect, no doubt. There is no difficulty in constructing a machine from those drawings and specifications. I really do not know, however, that it would work well. It would certainly work.

I suppose the questions of the effect of storing the magnetism and the precise moment at which electricity is generated are amongst the arcana of science?—Not exactly; we can make such calculations as to know what would occur again.

The actual process is to a great extent a matter of theory?—Just like all other natural forces in that respect.

His Lordship: You have a great many generalisations in electricity. You can rely upon them now as in other of nature's acts?—That is so.

The Court then adjourned, to meet again on Thursday morning.

(*To be continued.*)

Erratum.—In the middle of the first column on page 632 Mr. Varley is made to say: "I should *not* publish an account of what I had done in the Electrical Review." Mr. Varley requests us to state that the "not" should have been omitted, so that his letter would read: "I *should* publish an account of what I had done in the Electrical Review."

NEW PATENTS—1888.

17448. "An electric apparatus for choosing partners for purposes of amusement and otherwise. J. Gibson and C. B. Gibson. Dated November 30.

17479. "Improvements in switches and appurtenances used in an electric current." F. B. Nicholson and E. J. Jennings. Dated November 30.

17489. "Improvements in electric batteries." L. Fouque Dated November 30.

17511. "Improvements in insulators for supporting electric telegraph wires and the like." J. T. Greenwood. Dated December 1.

17537. "Improvements in cells for secondary batteries." M. Bailey and J. Warner. Dated December 1.

17568. "Improved means in connection with multiple electric circuits for measuring current passing in either of them as desired." Laurence, Paris and Scott, Limited, and R. Laurence. Dated December 1.

17590. "Improvements in apparatus and devices for carrying and separating the plates of secondary batteries." H. P. Holt. Dated December 3.

17601. "Improvements in the construction and arrangement of electrical bells." H. W. Handcock. Dated December 3.

17619. "Electrical measuring instrument." B. M. Drake and J. M. Gorham. Dated December 3.

17630. "Improved means and apparatus for effecting the successive bringing into action of two or more carbon pairs in electric arc lamps." S. Mathis and E. Boveroulle. Dated December 3.

17645. "Improvements in electro-motors." S. C. C. Currie. Dated December 4. (*Complete.*)

17688. "Improvements in and connected with electric railways." S. H. Short. Dated December 4. (*Complete.*)

17694. "Improvements in voltaic batteries." H. I. Harris and J. Garford. Dated December 4.

17718. "Improvements in electric cut-outs or circuit breakers." T. Parker and E. S. G. Rees. Dated December 5.

17746. "Improvements in the manufacture of ceiling roses, switches, cut-outs, or other similar electrical fittings." W. H. Sturge. Dated December 5.

17765. "Improvements in electrical railway signals." W. Markby. Dated December 5.

17777. "An improved ammeter." Sir C. S. Forbes, Bart. Dated December 5.

17783. "Improvements in the manufacture of wire or tape from electro-deposited metal for electrical or other purposes." G. A. Sweetser. Dated December 5.

17792. "Electrical street car, and appliances for working the same." M. R. Ward. Dated December 5.

17795. "An improvement in electrical arc lamps." J. Brockie. Dated December 6.

17798. "Improved insulating apparatus for terminating or shackling and looping telegraph, telephone, and other electrical wires." A. S. Dunn. Dated December 6.

17850. "Improvements in electric meters, or apparatus for measuring electricity." W. R. D. Frost. Dated December 6.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1887.

14445. "Improvements in the insulation of submarine telegraphic cables and other electrical conductors." R. Haddan. (A communication from abroad by E. G. Prillwitz, of Berlin.) Dated October 24. 4d. Claims:—1. Coating electrical conductors with an insulating material composed of powdered glass secured by metal foil, substantially as described. 2. Covering above insulating material with caoutchouc or equivalent enclosed in silk or other fabric with or without tarred felt asphaltum and wire covering, as described.

14461. "Improvements in electric accumulators or secondary batteries." A. Stetson. Dated October 24. 8d. Claim:—A storage battery plate, consisting of a plate or mass of active material enclosed in a perforated case or sheath of thin metal.

14632. "Improvements in electrically-lighting railway trains." I. A. Timmis. Dated October 27. 8d. Claims:—1. The placing of controlling magnets in the controlling circuit of a train electrically fitted for being electrically lighted in conjunction with an adjustable regulator switch, substantially as and for the purposes described. 2. The automatic lighting of all the lamps in a train electrically fitted for lighting that are held "out" (not lit) when any pair of couplers are parted, substantially as and for the purposes described.

16863. "Improvements in or connected with means for the automatic electrical distribution and charge of secondary batteries." F. King. Dated December 7. 11d. Has for its object to improve and simplify the means for charging and discharging secondary batteries, as described in the specification of letters patent No. 4,662, granted the 2nd day of April, 1886. The claims are 9 in number.

17175. "Improvements in phonographs and phonograms." G. E. Gouraud. (A communication from abroad by T. A. Edison, of America.) Dated December 14. 11d. The object of the invention is more especially to improve the recording and reproducing qualities of the instrument, to provide a proper motor for running the phonogram cylinder at a uniform speed, to provide a suitable phonogram cylinder and phonogram, and to arrange and construct the several parts of the machine so that its manipulation will be simple, readily understood and convenient for the purposes for which the machine is designed. The claims are 17 in number.

17409. "Improvements in electrical primers or fuses." C. A. McEvoy. Dated December 17. 6d. Claims:—1. An electrical primer or fuse formed of a cylindrical casing, a metallic stem passing centrally through and insulated from it, and two or more thin metallic wires passing from the inner end of the central stem to the cylindrical casing and surrounded by gun cotton or like material ignitable by heat. 2. The construction of electrical primers or fuses substantially as described and illustrated in the drawing.

1888.

1128. "Improvements in galvanic batteries." A. A. Fortin. Dated January 25. 11d. Claims:—1. The interposition between the elements of conducting studs, preferably of carbon, acting in the manner described and each formed with a shoulder upon which the bottom of the tray is supported, as shown and described. 2. Providing the overflow pipes through which the liquid flows from one tray to the next with a lip or drip nozzle to prevent the liquid spreading over the under surface of the tray, said overflow pipe being placed either on the inside or outside of the tray or provided with a spout, as specified. 3. The employment as terminal conductors of carbon plates coated with paraffin at the ends where the terminals are fixed, as and for the purpose specified. 4. The means of supporting the column by extensions of the top bar of the clamp by which the elements are combined together, the parts of said clamp in contact with the outside elements being insulated with India rubber, as shown and described.

1968. "Improved secondary battery or accumulator for the storage of electricity." W. Tilley. Dated February 9. 8d. Claims:—1. The use of perforated metal whose perforations are indented so as to form distance pieces to separate the plate. 2. The combination of lead or lead compound and zinc in the negative element. 3. The use of vulcanised tissue for porous diaphragm and insulator.

4456. "An improved method of administering galvanic currents for curative purposes." A. Collingridge. Dated March 23. 6d. Claim:—The application of galvanic currents to the body for preventive or curative purposes by means of a combined battery pile or thermopile and a sponge or pad moistened in a saline or acid solution serving as excitant, or as excitant and conductor, as described and explained.

5731. "Improvements in and relating to apparatus for measuring electric currents, which apparatus will also serve as a motor." H. H. Lake. (Communicated from abroad by Elihu Thomson, of America.) Dated April 17. 1s. 1d. The inventor proposes to make use of a liquid which is vaporisable, such as ether or alcohol, and to employ the electric current to produce a heating effect on the said liquid, thus giving rise to a vapour, which, being held in a confined space above the liquid, may cause a bodily movement of the latter into another receptacle or portion of receptacle containing the same. The claims are 12 in number.

5732. "Improvements in and relating to apparatus for measuring electric currents, which apparatus will also serve as a motor." H. H. Lake. (Communicated from abroad by E. Thomson, of America.) Dated April 17. 8d. The inventor utilises the heating effects of an electric current upon a confined body of air or other gas, or upon a fluid, such air, gas or fluid being contained in a suitable chamber and the expansion produced by the heat of the electric current being utilised to produce movement of a body such, for instance, as a body of liquid contained in a suitable receptacle and having the confined body of air, gas or expansible liquid resting on its surface. The claims are 4 in number.

5831. "Improvements in means or apparatus for lifting, lowering, or regulating the height of the elements in electric batteries." T. Schönherr-Schöner. Dated April 19. 8d. Consists essentially in a screw and nut arrangement worked from a small hand lever through toothed gearing. The plate to which the elements are attached is provided with a nut in which fits a multiple threaded screw of sharp pitch. At the top of this screw is fitted a small toothed wheel, which gears with a toothed sector or quadrant, the radii being so proportioned that the small wheel and consequently also the multiple screw makes one complete revolution for approximately one quarter turn of the sector. To the hinge pin or shaft of the sector is fitted a small hand lever on the top or outside of the cover of the battery, which hand lever is moved by hand through the above arc between two stops. The underside of this hand lever is fitted with a spring, which bears against a sector plate on the cover of the battery; the object being to ensure sufficient bite or friction to hold the handle, and consequently also the elements, at any position or height to which they may have been moved. The pitch of the screw is so arranged that a single revolution which corresponds with a motion of the hand lever through the full extent between the two stops raises the elements from their lowest position of immersion in the solution to the highest position above, clear of the solution; or lowers it from the latter to the former. The claims are 4 in number.

6157. "Improvements in lanterns for electric arc lamps, and in posts or columns for supporting the same." R. E. Kerr. Dated April 25. 6d. The main object of the said invention is to provide a lantern for an electric arc lamp, which will ensure an equal distribution of light, and will obviate in a great measure the existence of detrimental shadows. The claims are 5 in number.

6191. "A mode of preparing carbons for electric arc lighting." C. A. J. H. Schroeder. Dated April 26. 4d. 1. Dense carbon is first dipped into a dilute solution of calcic-chloride, so that the carbon is moderately saturated, after which it is taken out of the solution and left to dry; after it is dry, it is ready for use. 2. Carbon of loose structure is likewise first dipped into a dilute solution of calcic-chloride, and remains therein until the carbon is moderately saturated, after which it is taken out of the solution; the carbon is then brought, whether dry or not, into a bath of a solution of potassic-chlorate or potassic-nitrate, or sodic-nitrate of any other potassium or sodium compound which is soluble in water, or any composition of such salt solutions, in which solution the carbon must remain for a time, according to its density, hardness, and other properties. There is 1 claim.

7541. "Improvements in dynamo-electric generators or motors." W. P. Thompson. (A communication from abroad by H. W. Spang, of America.) Dated May 22. 8d. Claims:—1. The combination with the armature of a dynamo-electric machine, of a consequent pole field magnet having its poles presented to different points in the length of said armature, each convolution of the coils of said armature extending across the face of each of the field magnet poles. 2. The combination with the armature of a dynamo-electric machine, of a field magnet having two poles facing the axis of the armature, and presented to said armature at points diagonally opposite with reference to its axis, the separate convolutions of the armature coils extending through the field of each pole. 3. In a dynamo-electric machine, the combination with a ring armature, of pole pieces of opposite character presented to the periphery of the armature at different points in its length, the separate convolutions of the armature coils extending across the face of each pole piece. 4. In a dynamo-electric machine, the combination of a single continuous core of soft iron, wire wound upon the same forming a cylindrical armature, and a field magnet having consequent poles located in different transverse planes with reference to the axis of the armature. 5. In an electric machine, the combination of a continuous armature core, its axis, wire wound upon said core parallel with said axis, and two field magnet poles presented to different points in the length of the armature, and upon opposite sides thereof. 6. The combination of the armature shaft of an electric machine, an armature movable thereon, an automatic tightening device coupling the armature to the shaft, whereby the normal movement of the shaft during its operation, tends to tighten the grip of the armature upon the shaft, and a commutator coupled to and moving with the armature independently of the shaft.

7551. "Improvements in coupling devices for electrical and other purposes, and in indicators to be used in conjunction therewith." J. KENDALL and O. COOPER. Dated May 22. 8d. Claims:—1. A coupling device for electrical and other purposes, comprising bell-mouthed or conical parts, arranged to slide longitudinally upon rods or bars connected by means of universal joints with the conductors, shafts, or other objects to be coupled, substantially as and for the purposes specified. 2. The improved reversible coupling device, consisting of the parts constructed and combined, substantially as described with reference to the drawing. 3. The use in conjunction with electrical signalling apparatus provided with the improved coupling devices of the improved indicator, substantially as described with reference to the drawing.

7850. "Improvements in or relating to alternate current electric distribution." W. P. THOMPSON. (A communication from abroad by G. Westinghouse, jun., of America.) Dated May 29. 8d. Claim:—The combination of two or more incandescent lamps arranged in series, each lamp being shunted by a reactive coil, which is so proportioned as to offer a high resistance to the passage of the current when the lamp is in operation, but whose reaction, when the lamp is disconnected, effects a resistance approximately equal to that of the lamp.

7851. "Improvements in switches for electric circuits. W. P. THOMPSON. (A communication from abroad by G. Westinghouse, junior, of America.) Dated May 29. 8d. The object of the invention is to provide convenient and reliable means for securing the connections without danger to the operator, and in such manner that the apparatus will not be injured by the sparks formed upon completing and interrupting the connections. The claims are 3 in number.

CORRESPONDENCE.

The Insulation of Industrial Electrical Installations.

Referring to the articles and letter which have appeared in the last two numbers of the REVIEW on this subject, there are one or two points to which I should like to call attention.

The insulation resistance of a newly fitted up circuit is often very high, compared with what will be the average working resistance after the circuit has been in use for some time; and, if the object of defining a value for this resistance is to always obtain work up to a certain standard, then the tests should be made some months after the circuits are fitted, so that the wires, fittings, &c., may have time to get into their normal conditions.

To show more fully the reason for this, I will quote a case. When testing a circuit on board ship I found the fault was caused by a joint, the insulation of which consisted of a loose wrapping of compounded tape. This joint was in a metal pipe, and although it probably had tested all right when first put up, yet, of course, as soon as it got damp from the condensation in the pipe, there was practically a dead earth. This may be considered an extreme case, but I am afraid that many joints are made in which the same thing happens to a modified extent.

Another point, which seems to me to be important, is that the sub-circuits should all be arranged so that they can be separately tested, as it sometimes happens that practically all the leakage is due to one carelessly-made joint, or to an accidental abrasion of the insulating material; and, although the insulation resistance obtained may appear fairly good, considered as that of the whole installation, yet when it is taken as that of a small sub-circuit, it may point to a fault which after a little time would cause trouble.

Coming now to the insulation resistance between the positive and negative conductors, I see that Prof. Jamieson does not mention it in his letter, and M. Picou only mentions it as a test which should be taken when possible, adding that it should follow the same rule, but with a constant equal to "2 *k*," since the protection is doubled. Now, it appears to me that this test is at least as important as the test for leakage to earth, and should therefore be insisted on; and, further, that in many installations the resistance from wire to wire will be found to be less than that from the wires to earth. The reason of this is that the wires, being laid in grooved casing, have an additional insulation between themselves and earth; and, on the other hand, that it is a common practice to use a lighter insulation for the twin wires used with suspended lamps and for the wires in metal fittings, these being the very places where the wires are closest together.

I would therefore suggest that any discussion on this subject should include the question of the minimum allowable resistance between positive and negative conductors, and also a discussion generally of what tests should be made to enable us to get some further information about the lasting properties of the insulation of the wires, joints, fittings, &c., under the various conditions to which they may be subjected.

Stuart A. Russell.

December 5th, 1888.

Testing Insulation Resistance of Electric Light Cables by a 10,000 Volt Transformer.

From your description and figure in this week's ELECTRICAL REVIEW of the 10,000 volt transformer made by Messrs. Ganz & Co. for the "Menier" cable works, it appears that the apparatus is *only* used as a handy means of subjecting the dielectric of electric light cables, &c., to severe electrical stresses; and that, after the application thereof, the ordinary insulation resistance tests will have to be applied in order to ascertain whether the insulation has fallen below the required standard or not?

It would be interesting and instructive to know:—

1. If the drums carrying the cables and leads are made of metal, and are earthed during the application of the high pressure electrical currents?

2. If not made of metal, if the drums and coils are submerged in fresh or in salt water?

3. How long the stresses are applied and with what E.M.F. for cables which are to be afterwards used for 100 volts to 200 volts, &c., with continuous currents, as well as for 1,000 up to 10,000 volts with alternate currents?

4. What kinds of dielectrics have best withstood these stresses?

5. If any of our British manufacturers of electric light cables and leads have tried, or even think of trying such severe tests before issuing their cables; also, if they see any necessity for doing so?

Andrew Jamieson,
Prof. of Engineering.

The Glasgow and West of Scotland,
Technical College, *December 8th*, 1888.

A Correction.

By a misreading of my letter or by misprint, one word in my letter is twice over spelt wrongly, and conveys quite a different meaning to that intended. The word "notion" which occurs twice should be "motion." The "notion" is mine but the "motion" is Porte and Manville's.

By *motion* I mean the mechanical method of producing a reciprocating action of certain parts.

My reply to Mr. Esson's letter is simple. This governor has been in use three years at Broomhill, and was preceded by another of different construction two years before, dating from 1883.

David Salomons.

December 9th, 1888.